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2006 Integrated Monitoring Plan Background Document Rocky Flats, Colorado, Site

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Work Performed Under DOE Contract No. DE–AC01–02GJ79491
for the U.S. Department of Energy Office of Legacy Management.

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Acronyms and Abbreviations

Ag	silver
AL	action level; Alluvium or other unconsolidated surficial material
ALF	Action Levels and Standards Framework
Am	americium
AOC	Area of Concern [well]
AoI	analyte of interest
AQM	Air Quality Management
As	arsenic
ASMS	Analytical Services Management System
B	Building
BA	Biological Assessment
BD	[Upper hydrostratigraphic unit] bedrock
BDCWA	Big Dry Creek Watershed Association
Be	beryllium
BE	Biological Evaluation
BMIP	Beryllium Monitoring Implementation Plan
BMP	best management practice
BO	Biological Opinion
BZSAP	Buffer Zone Sampling and Analysis Plan
CAA	Clean Air Act
$CaCO_3$	calcium carbonate
CAD/ROD	Corrective Action Decision/Record of Decision
CAPARS	Computer Assisted Protective Action Recommendations System
CAQCC	Colorado Air Quality Control Commission
CAS	Chemical Abstracts Service
CCR	Code of Colorado Regulations
Cd	cadmium
CDOW	Colorado Division of Wildlife
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
cfs	cubic feet per second
CHWA	Colorado Hazardous Waste Act
COC	contaminant of concern
ComRad	Community Radiation [Program]
Cr	chromium
CRA	Comprehensive Risk Assessment
CRS	Colorado Revised Statutes
Cu	copper
CWA	Clean Water Act
CWD	chronic wasting disease
CWQCC	Colorado Water Quality Control Commission
DD	Decision document
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective

DRCOG	Denver Regional Council of Governments
EDDIE	Environmental Data Dynamic Information Exchange
EDE	effective dose equivalent
EPA	[US] Environmental Protection Agency
ESS	Environmental Systems and Stewardship
ETPTS	East Trenches Plume Treatment System
fCi	femtocuries
Fe	iron
FERC	Federal Energy Regulatory Commission
ft^3	cubic foot
FY	fiscal year
GIS	Geographic Information System
GPMPP	*Ground Water Protection and Monitoring Program Plan*
GWAP	*Ground Water Assessment Plan*
GWIS	Ground water intercept system
HQ	hazard quotient
HR	high resolution
HRR	*Historical Release Report*
IA	Industrial Area
IASAP	Industrial Area Sampling and Analysis Plan
ICP/MS	Inductively Coupled Plasma/Mass Spectroscopy
IDLH	Imminent danger to life and health
IDT	Intelligent Decision Technology
IHSS	Individual Hazardous Substance Site
IM/IRA	Interim Measures/Interim Remedial Actions
IMP	*Integrated Monitoring Plan*
Kaiser-Hill	Kaiser-Hill Company, LLC
L	liter
Li	lithium
LM	[DOE] Legacy Management
LRA	Lead Regulatory Agency
LSD	Laboratory Services Division
m	meter
m^3	cubic meter
MBTA	Migratory Bird Treaty Act
MDA	minimum detectable activity
mg	milligrams
Mgal	million gallons
MGD	million gallons per day
min	minute
M-K	Mann-Kendall
Mn	manganese
MOD	[Temporary] Modification
MOU	Memorandum of Understanding
µg	microgram
mrem	millirem
MSPTS	Mound Site Plume Treatment System
M2SD	mean plus two standard deviations

NA	not applicable/not available
Ni	nickel
NLR	no longer representative
NPDES	National Pollutant Discharge Elimination System
NREL	National Renewable Energy Laboratory
NSQ	Non-Sufficient Quantity
NTU	nephelometric unit
OLF	Original Landfill
OU	Operable Unit
P	phosphorus
PAC	Potential Area of Concern
PAM	Proposed Action Memorandum
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
Pb	lead
PBA	Programmatic Biological Assessment
pCi	picocurie
PM-Be	project-specific monitoring for beryllium in air
PM-Rad	project-specific monitoring for radionuclides in air
PNNL	Pacific Northwest National Laboratory
POC	Point of Compliance
POE	Point of Evaluation
POM	Point of Measurement
POP	*Pond Operations Plan*
ppb	parts per billion
PQL	Practical Quantitation Limit
Pu	plutonium
PU&D	Property Utilization and Disposal
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
R&IE	[EPA] Radiation and Indoor Air Environments Laboratory
RAAMP	Radioactive Ambient Air Monitoring Program
Rad-NESHAP	"National Emission Standard for Emissions of Radionuclides Other than Radon from DOE Facilities" (40 CFR 61, Subpart H)
RCRA	Resource Conservation and Recovery Act
Rev	revision
RFCA	*Rocky Flats Cleanup Agreement*
RFS	Rocky Flats Site
RFPO	Rocky Flats Project Office
RI/FS	Remedial Investigation/Feasibility Study
RMRS	Rocky Mountain Remediation Services
SAP	Sampling and Analysis Plan
SCMP	Site-wide Commitments Management Program
Se	selenium
SEEPro	Site Environmental Evaluation for Projects
SEP	Solar Evaporation Ponds, Solar Ponds
SID	South Interceptor Ditch
Site	Rocky Flats Environmental Technology Site

SOP	standard operating procedure
SPPTS	Solar Ponds Plume Treatment System
SSC	species of special concern
SVOC	semi-volatile organic compound
SWD	Soil and Water Database
SWPRG	Surface Water Preliminary Remediation Goals
S-K	Seasonal-Kendall [test]
T&E	threatened and endangered [species]
TBD	to be determined
TCE	trichloroethene
TDS	total dissolved solids
TIMS	thermal ionization mass spectrometry
TSP	total suspended particulates
TSS	total suspended solids
U	uranium
UBC	underbuilding contamination
UHSU	upper hydrostratigraphic unit
USACOE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
UTL	upper tolerance level
U/N	uranium, nitrate
VOA	volatile organic analysis
VOC	volatile organic compound
WARP	Well Abandonment and Replacement Program
WQCD	Water Quality Control District
WRW	Wildlife Refuge Worker
yr	year
Zn	zinc

1.0 Introduction

The Integrated Monitoring Plan (IMP) was revised for fiscal year 2005 (FY 2005) in accordance with the *Rocky Flats Cleanup Agreement* (RFCA) (U.S. Department of Energy [DOE], Colorado Department of Public Health and Environment [CDPHE], and U.S. Environmental Protection Agency [EPA], 1996) requirements. The resulting 2005 IMP (Kaiser-Hill 2005d) has since been revised to reflect later agreements among these parties that pertain to the monitoring performed at the Original and Present Landfills. In addition, this 2006 IMP omits sections of the 2005 IMP that were devoted to monitoring that was performed in support of Site closure now that the Site is closed. The 2005 revisions focused on improving integrated monitoring for closure projects, moving monitoring architectures toward their closure or post-closure configurations, and providing up-to-date documentation that reflects the most current technical approaches within the routine environmental monitoring programs. The revisions were the result of working group discussions, and were based on identified needs that were not previously addressed, or were based on changes in monitoring scope dictated by changes in the Rocky Flats Site (RFS or Site) operations and infrastructure. With the exceptions summarized above, the media-specific data quality objectives (DQOs) and monitoring specifications developed for the FY 2005 IMP are retained in this 2006 version.

This 2006 IMP will remain in effect until superseded by the final Site Corrective Action Decision/Record of Decision (CAD/ROD), which may occur as early as summer or fall 2006. Changes to the monitoring are expected to be implemented via the CAD/ROD. (Some anticipated changes are discussed in Section 3 of this IMP.) Changes specified in that document will be incorporated into and implemented through an attachment to the Long Term Stewardship and Maintenance Plan (LTS&MP) that will be issued upon the regulatory acceptance of the final CAD/ROD for the Site. Monitoring will then be performed in accordance with that document.

Project-specific DQOs were developed as part of the decision document or the IMP, as appropriate. The project-specific DQOs address protection of project personnel, collocated workers, off-Site populations, and the environment, and generally complement RFS-wide monitoring DQOs.

A key component of the DQO process and the IMP is data evaluation. To be successful, both RFS-wide and project-specific monitoring data must be continuously evaluated to support the DQO decision rules. Decision rules address baseline definition, relationships between various media, performance and compliance demonstration, and identification of unplanned conditions and trends. Actions based on data evaluation are specified by the decision rules. Actions also may involve modification of DQOs and monitoring specifications. For example, additional data have been required to adequately characterize observed conditions and potential impacts (e.g., exceedance of RFCA ground water action levels), and in some cases, to properly scope a proposed activity (e.g., environmental restoration and decommissioning projects, or changes to existing water management schemes). Data evaluation is discussed in the following media-specific sections and in RFS environmental program plans.

Data reporting and data exchange were considered during the development of the IMP. The data exchange mechanism, which was formalized as a RFCA requirement (Part 23, Section 266-270), provided both RFS-wide and project-specific monitoring data to appropriate monitoring entities and regulatory agencies, and allowed these groups to evaluate data needs associated with proposed activities (e.g., baseline characterization, sampling program design, and performance monitoring). The data management tools and reports needed for data exchange and interpretation were defined and employed. All entities were involved to ensure that the proper information was conveyed in a timely manner.

As with previous versions of the IMP, the plan presented herein should be considered dynamic. The monitoring programs evolved as remediation and closure grew near, as new remediation and closure activities were planned and initiated that required performance monitoring, as the regulatory setting changed, and as new data became available to improve the statistical design. Such changes were made by the multi-party working group and documented in updates to this plan. Periodic meetings of the working group were held, and resulting changes presented to other stakeholders. Notwithstanding the above, however, this 2006 version is not anticipated to change via gradual evolution. Instead, any changes to the monitoring are expected to be implemented via the final CAD/ROD for the Site, as discussed above.

1.1 Background

As the Integrating Management Contractor of RFS, Kaiser-Hill was responsible for closing the Site. This feat was declared accomplished on October 13, 2005. DOE accepted this declaration on December 8, 2005. Since that date, Site monitoring and maintenance has been performed by the technical assistance contractor to DOE Office of Legacy Management (LM), the S.M. Stoller Corp. (Stoller). Monitoring requirements have been inherited from Kaiser-Hill.

Soon after becoming the Integrating Management Contractor at RFS, Kaiser-Hill undertook a structured, comprehensive reevaluation of environmental monitoring programs. The objective was to develop monitoring specifications using the EPA's established DQO process. The process involved EPA; DOE; CDPHE; the cities of Broomfield, Northglenn, Arvada, and Westminster; and the Kaiser-Hill team. The reevaluation identified unnecessary monitoring, areas for improvement in the monitoring programs, and efforts to ensure protective and compliant programs. Using the consensus specifications or DQOs, an optimal data collection design was determined. This approach demonstrates compliance with the myriad federal and state regulations, and DOE orders, and supports the decisions that must be made to protect human health and the environment with an acceptable degree of certainty. The monitoring programs of the regulators and cities were included and also modified to develop an integrated, multi-party monitoring program. The development and maintenance of this integrated program became a requirement of RFCA issued on July 19, 1996.[1] The IMP is a result of this process.

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[1] RFCA Part 21 Paragraphs 267 and 268 state: "In consultation with CDPHE and EPA, DOE shall establish an IMP that effectively collects and reports the data required to ensure the protection of human health and the environment consistent with the Preamble, compliance with this Agreement, laws and regulation, and the effective management of RFS's resources. The IMP will be jointly evaluated for adequacy on an annual basis, based on previous monitoring results, changed conditions, planned activities and public input. Changes to the IMP will be made with the approval of EPA and CDPHE. Disagreements regarding modifications to the IMP will be subject to the dispute resolution process described in Subpart 15B or E, as appropriate."
"All Parties shall make available to each other and the public results of sampling, tests, or other data with respect to the implementation of this Agreement as specified in the IMP or appropriate sampling and analysis plan. If quality assurance is not completed within the time frames specified in the IMP or appropriate sampling and analysis plan, raw data or results shall be submitted upon the request of EPA or CDPHE. In addition, quality assured data or results shall be submitted as soon as they become available."

The DQO process is a structured decision-making process that requires the identification of and agreement on decisions for which data are required. This process results in the specifications needed to develop a protective and compliant monitoring program. Specifications include qualitative and quantitative statements that include the type, quality, and quantity of the data required to support decision making. The formal DQO process is documented in two EPA documents (EPA 1993; EPA 1994). In September 1994, DOE institutionalized the DQO process for environmental data collection activities. The process was implemented to balance DOE's environmental sampling and analysis costs with the need for sound environmental data that address regulatory requirements and stakeholder concerns. Specific steps in the DQO process include:

- Identify and define problems to be solved;
- Identify decisions to be made relative to the problem;
- Identify inputs to the decisions (data needed to make decisions);
- Define study boundaries or scope of the problem and the decision;
- Develop decision rules (IF/THEN action statements);
- Specify limits on decision errors (acceptable types and degrees of uncertainty); and
- Develop and optimize the design for obtaining data.

The goal of using this approach was to reevaluate the basis and focus of existing programs, increase the defensibility of monitoring, and incorporate regulatory changes (e.g., water quality standards and cleanup levels) associated with RFCA. The RFCA requirements have been incorporated into the DQOs.

Implementation of the DQO process forces data suppliers and data users to consider the following questions:

- What decision has to be made?
- What type and quality of data are required to support the decision?
- Why are new data needed for the decision?
- How will new data be used to make the decision?

DOE and Kaiser-Hill recognized that RFS could no longer have separate, non-integrated sampling and analysis activities performed by various entities at RFS (e.g., environmental restoration, decommissioning projects, and Environmental Media Management), or between RFS, the cities, CDPHE, and EPA Region VIII. DOE and Kaiser-Hill also realized that they should not work alone; therefore, an integrated monitoring working group was formed with representatives from DOE, the Kaiser-Hill team, EPA, CDPHE, and the cities of Broomfield, Northglenn, Arvada, and Westminster. The group worked to develop consensus on what data were needed, how data would be used, and, based on these specifications, what sampling and analysis plans would be needed. The responsibility for data generation was then spread across these entities in a logical way. In developing the requirements for an integrated monitoring plan, the decisions and multimedia data requirements associated with RFCA; the Resource Conservation and Recovery Act (RCRA); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); the federal Clean Air Act (CAA); the Clean Water Act (CWA); Colorado Water Quality Control Commission (CWQCC) standards; natural resource management regulations; RFS-specific cleanup agreements; and DOE orders were considered. After data requirements to support each of the desired decisions were identified, data collection was streamlined by looking for opportunities to use measurements for more than one decision.

Four DQO working groups (i.e., surface water, ground water, air, and ecological resources) were tasked with developing an integrated monitoring plan. Each group met regularly to work through the DQO process for each decision that required monitoring data. In addition, the four groups met together to discuss data needs across media, share progress, ensure consistency, and identify problems. DQO facilitators and statisticians, sponsored in part by DOE Headquarters, assisted the integrated monitoring working group in developing the DQOs, evaluating the adequacy of existing designs, and developing new sampling and analysis plans. The results of these efforts represent a multi-party consensus agreement and are documented in this document by environmental media. Integration was achieved between monitoring entities, regulatory programs, and environmental media. Interactions between media are discussed in Section 7.0 of this IMP Background Document, Rev. 1.

This document covers environmental monitoring conducted by DOE and Stoller, as well as monitoring conducted by CDPHE and the cities where interface and integration opportunities exist. Other monitoring conducted by CDPHE and the cities may be related to RFS, but does not present integration opportunities (e.g., monitoring of area reservoirs conducted by the cities; spot checks conducted by CDPHE).

1.2 Future of the Integrated Monitoring Plan

Following completion of the cleanup and closure of RFS and the issuance of a final CAD/ROD for the Site, DOE's Office of Environmental Management (EM), which has been responsible for the cleanup, will transfer jurisdiction of the lands that DOE retains to DOE-LM. LM was established in December 2003 to conduct long-term management activities for DOE sites that no longer support DOE's ongoing missions, including disposal sites and other remediated sites such as RFS. At RFS, LM will also be responsible for compliance with long-term requirements outlined in the Site's CAD/ROD and implemented through the post-closure regulatory agreement. As described previously, monitoring changes may be specified in that CAD/ROD. Any such changes will be incorporated in an attachment to the post-closure regulatory agreement, which will be issued following finalization of the CAD/ROD.

Monitoring in accordance with this IMP is now performed by DOE-LM/Stoller for DOE-EM. The scope of work that will transition to LM upon finalization of the Site. CAD/ROD is anticipated to be very similar to that outlined in this IMP.

2.0 Surface Water Monitoring

In accordance with the Preamble to RFCA, RFS operates a robust surface water monitoring system to provide water quality information at the Site, to assure public safety, and to keep the public informed. This chapter of the IMP Background Document describes the surface water monitoring objectives implemented to achieve these goals.

2.1 Introduction

Surface water is defined here as water flowing above ground in natural or manmade channels, and water detained in Site retention ponds. Surface water may originate as rainfall, surface water flowing from upgradient sources, or ground water discharge to the surface via seeps.

2.1.1 Summary of Monitoring Objectives

This chapter describes surface water monitoring objectives implemented at the Site. The monitoring described herein integrates surface water monitoring activities across the Site that are performed under RFCA, including much of the Site monitoring performed by the cities and CDPHE.

The DQO process was used to determine decisions regarding necessary and sufficient monitoring requirements. The process yielded multiple data-driven decisions requiring various levels of priority and confidence.

Location-specific sample collection protocols are discussed in the following surface water monitoring sections. For decision rules requiring composite sampling, the protocols are specified in the related section on data types and frequency. Composite samples are collected using a continuous flow-paced method. Continuous flow-paced composite samples are collected during all flow conditions by automated samplers programmed to collect a grab sample after each specified volume of stream discharge is measured by the flow meter.

This 2006 IMP includes significant revisions related to Site physical completion. As a result, prior decision rules have been modified, and in some cases deleted entirely.

In this document, surface water monitoring objectives (or “decision rules” under the DQO process) are organized in a roughly upstream-to-downstream order, beginning with discharges within the former Industrial Area (IA) and ending at the drinking water reservoirs downstream. This order is depicted in Figure 2−1. These monitoring objectives are summarized in the following paragraphs and are discussed in detail in the remainder of this section.

Monitoring objectives that do not fit into the upstream-to-downstream sequence are discussed in Section 2.2 as Site-Wide Monitoring Objectives. The first of these objectives is monitoring to ensure safe operation of the Site retention pond dams. Safety monitoring to avoid dam breaching is discussed first (Section 2.2.1), in recognition of its unique importance in avoiding imminent danger to life and health (IDLH). Furthermore, some Site-wide monitoring needs simply cannot be known in advance. These are discussed as Ad Hoc Monitoring (Section 2.2.2). Monitoring may also be performed to evaluate water management alternatives and fate and transport of constituents. Specifically, in this document, this refers to Indicator Parameter Monitoring for

Analytical Water quality Data Assessment, as discussed in Section 2.2.3. Finally, Investigative Monitoring provides for collection of data upstream of Points of Evaluation (POEs) and Points of Compliance (POCs) for potential use in addressing reportable water quality results under RFCA (Section 2.2.4).

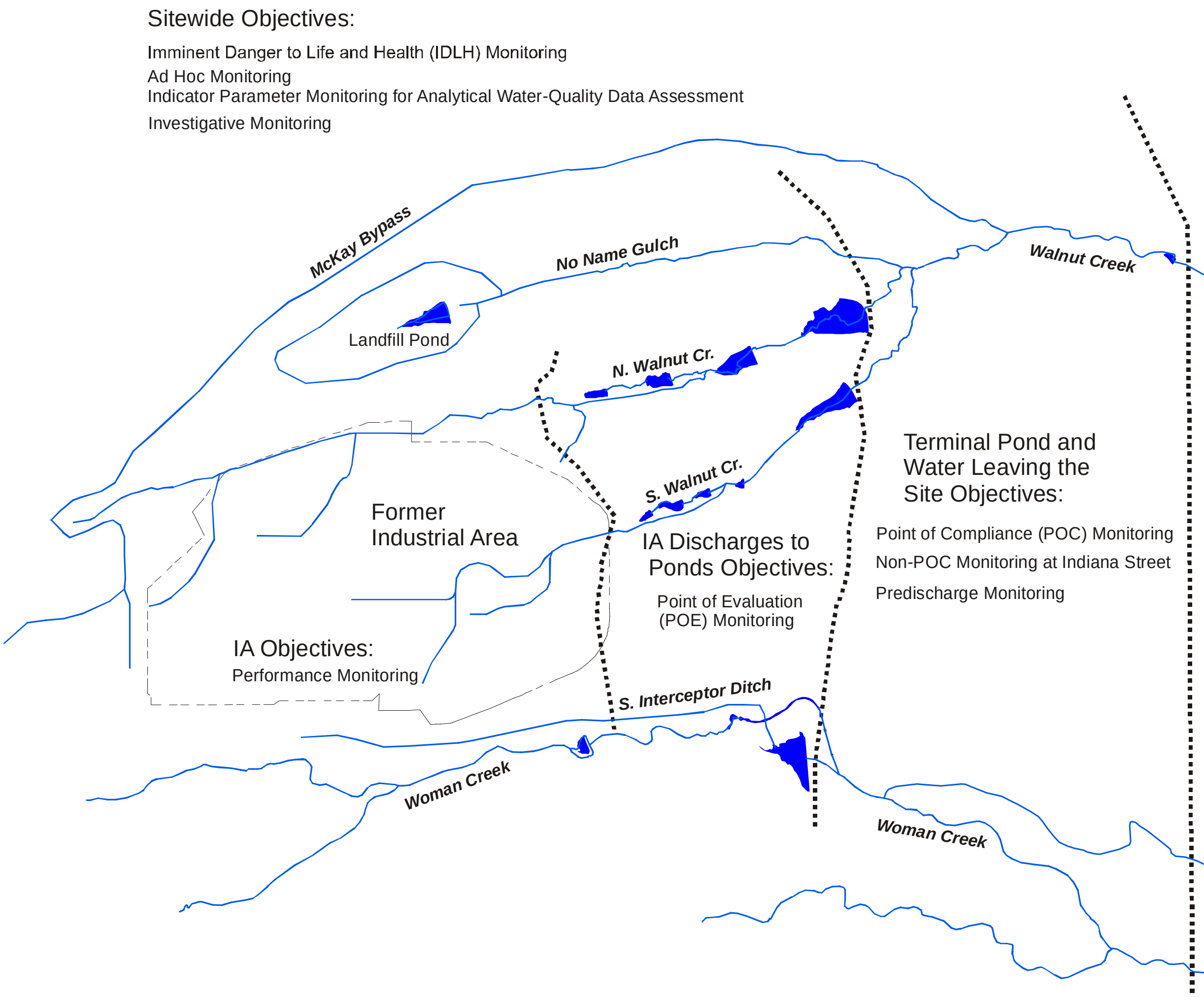

Figure 2–1. Conceptual Model of Site Monitoring Objectives

The first group of upstream-to-downstream monitoring objectives are the IA Monitoring Objectives. In this 2006 IMP, the IA is more loosely defined to also include the Present Landfill, the Original Landfill, and the passive ground water treatment systems. Individual remedies (generally located within the former IA) may warrant Performance Monitoring (Section 2.3.1) to evaluate surface water impacts specifically from a remedy.

The next group of upstream-to-downstream monitoring objectives (Section 2.4) deals with discharges from the former IA to the ponds. RFCA requires the Site to identify and correct previously undetected releases of contaminants from the former IA to the ponds. RFCA specifies monitoring for the upstream reaches of the Site drainages (above the ponds) and specifies action levels for contaminants (Action Level and Standards Framework [ALF]). This POE Monitoring is addressed in Section 2.4.1.

Continuing downstream to the next group of monitoring objectives, terminal retention pond discharges and surface water leaving the Site are monitored. Predischarge monitoring of terminal ponds occurs prior to controlled discharges (Section 2.5.1). The Site also monitors at POCs below the terminal ponds to demonstrate that Site discharges meet stream standards (Section 2.5.2), as specified in RFCA. Further, there are RFCA POCs on Walnut and Woman Creeks that are monitored at the Site boundary at Indiana Street. Non-POC Monitoring at Indiana Street addresses monitoring for contaminants of concern (COCs) that are not analytes of interest (AoIs) under RFCA (Section 2.5.3).

The State and downstream communities are also concerned that the water quality in downstream reservoirs might be degraded by Site discharges. Section 2.6 addresses Off-Site Monitoring Objectives. These data are used to make decisions regarding potential use of the water for drinking and irrigation, and for compensatory actions such as providing alternate water sources and reservoirs.

Section 7.0 addresses interfaces between surface water and other media. For example, contaminants in ground water and soil could conceivably contaminate surface water, and surface water could subsequently adversely affect habitats of endangered species. Monitoring objectives to evaluate these interactions are addressed in Ground Water Monitoring, Section 3.0.

Table 2−1 presents a summary of the surface water monitoring performed by the Site. Surface water monitoring performed by regulators and stakeholders is not included in Table 2−1.

2.1.2 Hydrologic Setting

This section is included only as an introduction for members of the public not already familiar with the Site. This section contains no monitoring requirements or other commitments or agreements between the parties. This section does not contain material that affects the interpretation of the rest of the document.

Geographically, Site surface waters are bounded

- Upstream by the West Diversion Ditch (McKay Bypass);
- On the south, by the South Interceptor Ditch (SID) or by Woman Creek, subject to discussion and context;
- By the Present Landfill drainage (No Name Gulch) on the north; and
- On the downstream end by Great Western Reservoir and Standley Lake or by Stream Segment 1 of Big Dry Creek, subject to discussion and context.

The stream drainages leading off Site, from north to south, are Rock Creek, Walnut Creek, and Woman Creek. Figure 2−2 illustrates the latter two drainages and their tributaries. North Walnut Creek flows through the A-series ponds, and South Walnut Creek flows through the B-series ponds.

2.1.3 Assumptions

The Surface Water IMP Working Group made several assumptions to focus the monitoring program on practical concerns. These assumptions acknowledge that monitoring for all possible Site conditions, contaminants, and practices would be an inefficient use of limited resources. The Working Group's planning assumptions are presented below. If an assumption became invalid during the effective period of a plan, then some of the monitoring that was included/excluded on the basis of that assumption was reconsidered and possibly discontinued/implemented in future years. Deviation from these assumptions required prior approval of EPA, CDPHE, and DOE, as per RFCA Part 23, paragraph 267.

Monitoring objectives specified herein will be implemented by the Parties, subject to funding constraints and priorities, as specified in RFCA Part 11, Subpart A.

- This plan incorporates surface water monitoring of Site discharges to surface water, and contaminant impacts down to and including Broomfield and Westminster water supplies. Monitoring and decisions by the Site, the State, and the cities are included.
- Decisions regarding IDLH are deserving of special attention and will be segregated from decisions regarding likely low-risk health concerns to ensure that confusion will not arise regarding the priority of IDLH decisions over strictly water quality decisions.
- For purposes of computation in regulatory reporting, the sample date for a multi-day composite sample will be the date that the sample was started. Although this will give the impression that multi-week samples are being reported months late, this convention is consistent with other Site data.
- Termination for Cause: Successful completion of a flow-paced composite sample is determined by several factors that are evaluated by the sampling team. These include, but are not limited to, the required sample volume for analysis (normally ≥ about 4 liters [L]; see Non-Sufficient Quantity discussion), equipment failures, off-normal conditions (e.g., emergencies, severe weather, other *force majeure*), or health and safety concerns.
- Non-Sufficient Quantity (NSQ): If sample accumulation is terminated for cause, and sample volume is inadequate for routine laboratory analyses, then no analyses are required, and the sample will not be used in the computation of compliance values. For example, routine laboratory analysis for plutonium (Pu) and americium (Am) require 4.0 L. Therefore, samples of less than 4.0 L may be discarded and not used in the computation and evaluation of compliance parameters, but must be reported. This requirement may be referred to as the NSQ requirement regarding insufficient quantity of sample.
- NSQ sample volume size has been discussed at several previous forums. As of the 4th Quarter FY 2005 revision, the minimum sample volume needed to meet the minimum detectable activity (MDA) for Pu and Am remains 4.0 L. If the subcontracted laboratories suggest that a modified sample volume could provide an acceptable MDA, a change in the NSQ volume may be warranted.

Table 2–1. Summary Table of RFS Surface Water Monitoring

Location Code	Description	Sample Type(s)	Objective(s)	Analyte(s)	Sample Frequency	Field Data	Telemetry
GS01	Woman Creek at Indiana Street	Continuous flow-paced composites	POC	Pu, Am, isotopic U, TSS*	Varies with hydrology	Flow rate; precipitation (PG58)	Yes
GS03	Walnut Creek at Indiana Street	Continuous flow-paced composites	POC	Pu, Am, isotopic U, TSS*	Varies with hydrology	Flow rate; precipitation (PG59)	Yes
			Non-POC	Nitrate	Varies with hydrology (pond discharges only)		
GS05	Woman Creek at west fenceline	Continuous flow-paced composites	Investigative; Performance	Isotopic U, selected metals	Varies with hydrology (monthly if triggered by DQO)	Flow rate; precipitation (PG61)	Yes
		Grabs	Performance	Selected VOCs	Quarterly (monthly if triggered by DQO)		
GS08	Pond B-5 Outlet	Continuous flow-paced composites	POC	Pu, Am, isotopic U, TSS*	Varies with pond discharge frequency	Flow rate	Yes
			Non-POC	Nitrate			
GS10	South Walnut Creek upstream of the B-1 Bypass	Continuous flow-paced composites	POE	Pu, Am, isotopic U, total Cr and Be, dissolved Ag and Cd, hardness, TSS*	Varies with hydrology	Flow rate (IDLH location)	Yes
		Grabs	Performance (GW support)	VOCs	Semi-annual		
GS11	Pond A-4 Outlet	Continuous flow-paced composites	POC	Pu, Am, isotopic U, TSS*	Varies with pond discharge frequency	Flow rate (IDLH location)	Yes
			Non-POC	Nitrate			
GS12	Pond A-3 Outlet	NA	IDLH	NA	NA	Flow rate (IDLH location)	Yes
GS13	North Walnut Creek above Pond A-1	Continuous flow-paced composites	Investigative; Performance (GW support)	Isotopic U	Varies with hydrology	Flow rate (IDLH location); precipitation (PG73)	Yes
		Grabs	Performance (GW support)	Nitrate	Semi-annual		
GS31	Pond C-2 Outlet	Continuous flow-paced composites	POC	Pu, Am, isotopic U, TSS*	Varies with pond discharge frequency	Flow rate (IDLH location)	Yes
GS33	No Name Gulch at confluence with Walnut Creek	NA	AdHoc	NA	NA	Flow rate	Yes
GS51	Drainage area south of 903 Pad/Lip tributary to the SID	Continuous flow-paced composites	Investigative	Pu, Am, TSS*	Varies with hydrology	Flow rate	Yes
GS59	Woman Creek 700 feet east of Original Landfill (OLF)	Continuous flow-paced composites	Investigative; Performance	Isotopic U, selected metals	Varies with hydrology (monthly if triggered by DQO)	Flow rate; precipitation (PG74)	Yes
		Grabs	Performance	Selected VOCs	Quarterly (monthly if triggered by DQO)		
GWISINFNORTH, GWISINFSOUTH	North and South Ground Water Intercept System Influents to Present Landfill (PLF) Treatment System	Grabs	Performance	Selected VOCs, isotopic U, selected metals, nitrate/nitrite	Quarterly	NA	No
PLFPONDEFF	Outlet of East Landfill Pond	Grabs (triggered by DQO)	Performance	Selected by DQO	Monthly (if triggered by DQO)	NA	No
PLFSEEPINF	PLF Seep Influent to PLF Treatment System	Grabs	Performance	Selected VOCs, isotopic U, selected metals	Quarterly	Manual flow rate at sample time	No
PLFSYSEFF	PLF Treatment System Effluent	Grabs	Performance	Selected VOCs, selected SVOCs, isotopic U, selected metals	Quarterly	NA	No
POM2	South Walnut Creek at Pond B-4 outlet	Grabs	Performance	VOCs	Semi-annual	NA	No
POM3	South shoreline of Pond B-2	Grabs	Performance	Coordinated with CDPHE	Coordinated with CDPHE	Coordinated with CDPHE	No
Pond A-3	North Walnut Creek interior pond	NA	IDLH	NA	NA	Pool elevation; piezometer levels	Yes
Pond A-4	North Walnut Creek terminal pond	Grabs	Predischarge	VOCs, Pu, Am, isotopic U	Prior to each discharge	Pool elevation; piezometer levels (IDLH location)	Yes
Pond B-5	South Walnut Creek terminal pond	Grab	Predischarge	VOCs, Pu, Am, isotopic U	Prior to each discharge	Pool elevation; piezometer levels (IDLH location)	Yes
Pond C-2	South Interceptor Ditch (SID) / Woman Creek terminal pond	Grab	Predischarge	VOCs, Pu, Am, isotopic U	Prior to each discharge	Pool elevation; piezometer levels (IDLH location)	Yes
East Landfill Pond	Present Landfill pond	NA	IDLH	NA	NA	Pool elevation; piezometer levels	Yes

Table 2−1 (continued). Summary Table of RFS Surface Water Monitoring

Location Code	Description	Sample Type(s)	Objective(s)	Analyte(s)	Sample Frequency	Field Data	Telemetry
SPP DISCHARGE GALLERY	Outfall of Solar Ponds Plume Treatment System to N. Walnut Creek	Grabs	Performance	Total U, nitrate	Semi-annual	NA	No
SW018	North Walnut Creek tributary west of former Building 771 area	Continuous flow-paced composites	Investigative	Pu, Am, TSS*	Varies with hydrology	Flow rate	Yes
		Grabs	Performance	VOCs	Semi-annual		
SW027	Downstream end of SID at Pond C-2	Continuous flow-paced composites	POE	Pu, Am, isotopic U, total Cr and Be, dissolved Ag and Cd, hardness, TSS*	Varies with hydrology	Flow rate (IDLH location)	Yes
SW093	Downstream end of SID at Pond C-2	Continuous flow-paced composites	POE	Pu, Am, isotopic U, total Cr and Be, dissolved Ag and Cd, hardness, TSS*	Varies with hydrology	Flow rate	Yes
RPTR	Telemetry repeater on mesa north of N. Walnut Cr.	NA	NA	NA	NA	Precipitation (PG72)	Yes
RPT2	Telemetry repeater on mesa SW of Pond C-2	NA	NA	NA	NA	Precipitation (PG55)	Yes
RPT3	Telemetry repeater on mesa SW of POC GS03	NA	NA	NA	NA	Precipitation (PG56)	Yes

Notes: Flow rate and precipitation is continually collected at 5-minute intervals
TSS* = total suspended solids; collected for flow-paced composites when within 7-day hold time
VOCs = volatile organic compounds
SVOCs = semi-volatile organic compounds
DQO = data quality objective
U = uranium
Pu = Pu-239,240
Am = Am-241
POC = Point of Compliance
POE = Point of Evaluation’

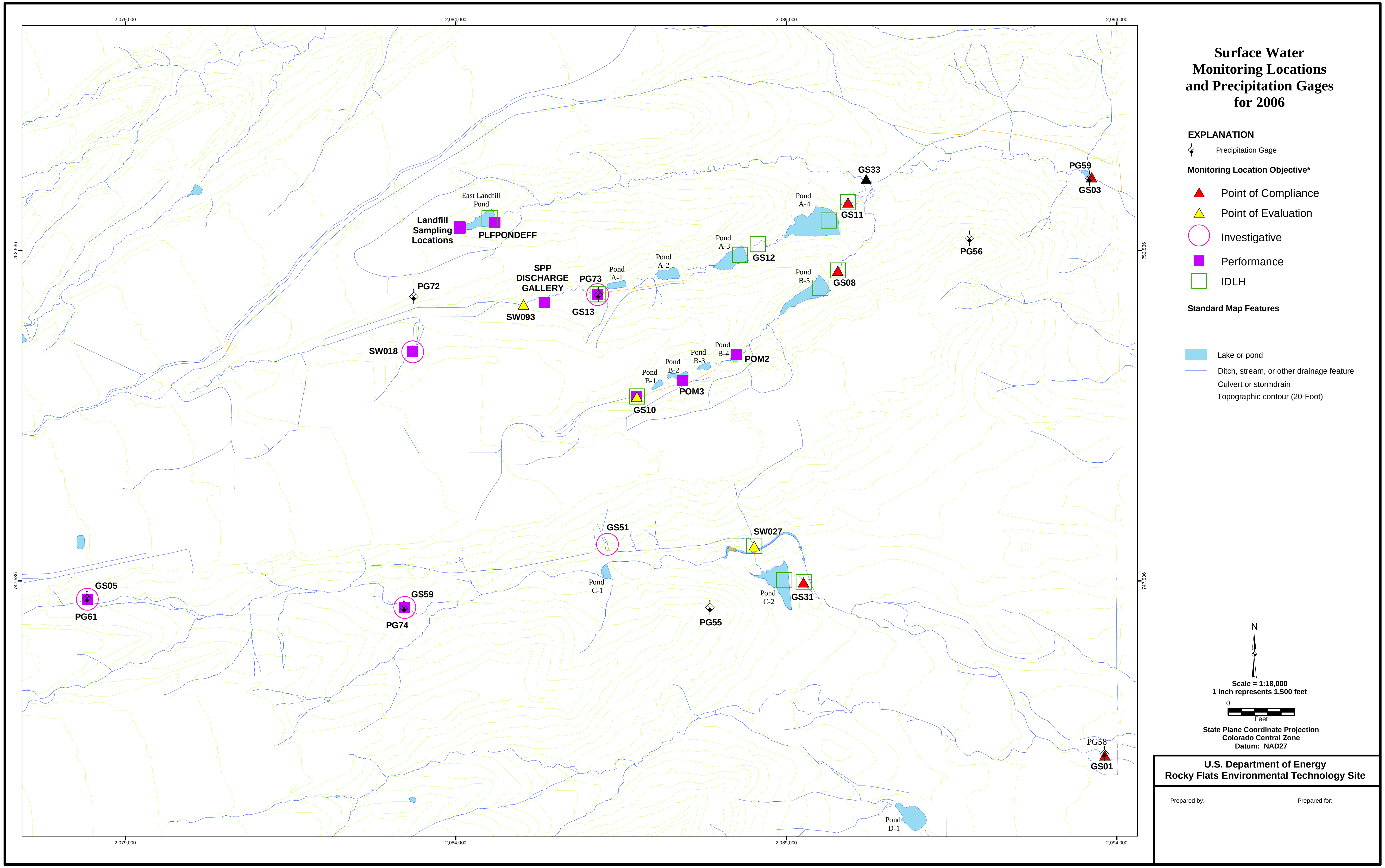

Figure 2–2. Surface Water Monitoring Locations and Precipitation Gauges

- The 30-day moving averages will be computed twice each month, within five working days of the 15th day and the last day of the month, for sample results received between these dates, and reported per the RFCA.
- The 12-month rolling averages will be computed once each month for the last day of each month, within five working days of the last day of the month, for sample results received between these dates, and reported per the RFCA.
- Where there is no significant flow, there may be no composite samples completed within a compliance calculation period. However, flow-paced sampling will continue during dry periods, even though flows may be so low that it may take longer than the required compliance period to fill the composite sample container.
- If no samples are taken during a compliance interval due to a no-flow condition, then no sample result will be available for use in the computation of compliance values, and no such value will be reported for that period.
- Samples taken for RFCA monitoring under this plan must be reported, even if they are not analyzed, and the reason for not analyzing (e.g., NSQ) must also be reported.
- Monitoring data acquired under the same procedural controls as used for RFCA monitoring are actionable[2] under RFCA and applicable regulations, even though it may not have been specifically identified as an AoI in Tables A−1 and A−2 in Appendix A.
- Many areas of RFS are linked by the flow of water within and above the ground surface in an upstream-to-downstream direction. Contaminants monitored in one area may have originated in an upstream area.
- These monitoring objectives are based on requirements set forth in the CWA and Colorado Water Quality Control Act.
- Each monitoring objective that requires comparison to a baseline presupposes that the establishment of a baseline will be performed before decisions are made based on the data. Each monitoring objective that specifies decisions based on statistical tests assumes that variability of data will be established before decisions are made on the basis of the data.

2.1.4 Outstanding Issues

- RFS operators, as in past years, continue to assess changing the pond operations protocol from batch discharge to controlled detention for off-Site release of surface waters. It is likely that this issue will be addressed in the near future.
- Terminal ponds will continue to be operated in a batch mode to the extent practicable for the foreseeable future.

2.1.5 Quality Control Objectives For Collection/Evaluation of Surface Water Data

General requirements for the Surface Water Monitoring Program activities are covered under the *Legacy Management CERCLA Sites Quality Assurance Project Plan* (LM QAPP; DOE 2006d) and associated standard operating procedures (SOPs). The LM QAPP is consistent with the

[2] The term “enforceable” has been reserved for POC standards, as opposed to POE action levels. The term “actionable” is intended here to include enforcement actions, actions taken in response to action level exceedances, and any other action required under RFCA in response to monitoring data.

quality assurance (QA) program requirements of DOE Order 414.1C, *Quality Assurance* (DOE 2005a), and environmental data operations requirements in EPA QA/R-5, *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA 2001) and ANSI/ASQ E-4-2004, *Quality Systems for Environmental Data and Technology Programs: Requirement with Guidance for Use* (ANSI/ASQ 2004). The Program covers environmental activities and describes the requirements, methods, and responsibilities of environmental management, staff, contractors, and vendors for achieving and ensuring quality. The LM Sampling and Analysis Plan (SAP) (DOE 2006e) presents the methods by which surface water monitoring is performed at the Site. Non-routine evaluations and special sampling projects will be governed by task-specific work plans, SAPs, or other work control documents.

The LM QAPP generally covers quality control (QC) for the following components of the surface water program:

- Developing DQOs;
- Collecting and analyzing samples according to approved procedures; and
- Reducing, reporting, and managing data and records in a controlled manner.

2.1.5.1 Field Data Collection

QC objectives for the collection of field parameters and representative samples of surface water are established to ensure that data are of sufficient quality to support the decisions identified in the following sections. The QC objectives for field data collection are

- Sampled water is representative of surface water;
- Sampling techniques do not introduce contaminants into samples;
- Sampling techniques are generally standardized for improved reproducibility and comparability of results; and
- Water levels are measured precisely enough to detect minor fluctuations (approximately ±0.01 foot) in flow.

The applicable task-specific SOPs ensure that quality samples are collected for use in environmental decision making.

2.1.5.2 Data Management

Prior to Site closure, surface water monitoring field data and laboratory analyses were maintained in the Soil and Water Database (SWD). This is a relational database that stored environmental data collected at RFS. Since Site closure, those data have been moved to a new database, to which all new data are appended; this database is called SEEPro. Data analysis and reporting now use data extracted from SEEPro instead of SWD.

SEEPro uses Oracle® software for data management and Microsoft® Access for data retrieval and display. It compiles water quality, field parameter, sample tracking, sample location, and water level data for ground water, surface water, boreholes, soils, and sediment samples. Field parameter data include such information as sample location, sample date, pH, turbidity, conductivity, and temperature. Chemical information (CAS registry numbers, analytical results, and detection limits) is also included. Specific procedures for verification of database information received from subcontractors, or input directly into SEEPro, are followed. These procedures provide QA documentation, which ensures that available data have been incorporated and entered or uploaded properly into SEEPro. Data integrity is maintained with standardized error checking routines used when loading data into SEEPro. Other procedures address database system security and software change control.

The RFS field data are entered through the FieldPar field data entry system. This system is a data entry module that is compatible with the SEEPro database, and is used in the office by field personnel. Data entered into FieldPar are verified by the sampler before loading into the main SEEPro database.

Spatial information for surface water data features are located in the LM Geographic Information System (GIS) database. Some of the surface water data features included are streams/creeks, lakes/ponds, topographic contours, and historical RFS facilities. This system uses an ESRI® ArcGIS™ suite of software to store and present data. Automated monitoring locations and other sample location data features are derived from location information stored in the SEEPro database.

2.1.6 Surface Water Reporting

Data specified in the surface water monitoring objectives are used in decision making. These data are managed in RFS databases for subsequent queries (secondary data usage is quite common). Some typical (though non-inclusive) examples of data usage are described below.

- IDLH data are used to make pond management and operational decisions; for example, to determine when valves and flood gates should be opened and closed. Some of these data may be reported verbally and/or electronically (informal email) to the DOE, Rocky Flats Project Office (RFPO), and regulators during the decision-making process, but no formal report of pond levels, valve positions, and piezometer readings is produced as a separate or special regulatory report.
- If data helped to locate a new contaminant source, then the source and data would be reported for appropriate management action.
- Ad hoc monitoring requested by RFS parties is reported to the requestor.
- Data collected for RFCA POE and POC monitoring locations are used to calculate reporting values for the AoIs. If the calculated values exceed the applicable reporting threshold (action level or standard), formal notification is made to the RFCA Parties pursuant to Attachment 5 of RFCA.

There are a few routine reports prepared for surface water data. Current reports are

- CDPHE routinely reports predischarge and community-assurance monitoring results to RFS and cities; and
- Quarterly Reports of Site Surveillance and Maintenance Activities which will contain a summary of surface water monitoring data collected in the respective period at RFS.
- Annual Reports of Site Surveillance and Maintenance Activities which will contain a complete evaluation of surface water monitoring data collected during the calendar year.

2.2 Site-Wide Monitoring Objectives

The monitoring objectives in this IMP are generally presented in an upstream-to-downstream order. This section addresses monitoring objectives that cannot be ordered in that way. This section also addresses cross-cutting monitoring objectives such as safe operation of the dams (Section 2.2.1); special request (ad hoc) monitoring (Section 2.2.2); the use of indicator parameters to evaluate constituent fate and transport and to design water management options (Section 2.2.3); and investigative monitoring in support of POE and POC evaluation (Section 2.2.4). None of this monitoring is necessarily confined to a single geographical area of RFS.

Figure 2−2 shows specific monitoring locations referenced under each objective. In the interest of fiscal and operational efficiency, many of these locations collect data to support multiple monitoring objectives. The location codes in Figure 2−2 are those used in the RFS SEEPro database.

2.2.1 Imminent Danger to Life and Health Decision Monitoring

This IDLH section uses the term "action level" in reference to dam operations. This is an entirely different usage unrelated to the RFCA ALF discussed elsewhere in this document.

The Site has a network of retention ponds with earthen dams (Figure 2−2). Failure of an earthen dam would present an IDLH condition as defined by safety and health professionals. In general, Site retention ponds can hold a limited amount of water safely. Water may be discharged from these ponds through the outlet works or by pumping. Water does not normally overtop the dams, which would likely be damaged and could fail under such conditions. Heavy rain or snowmelt runoff can challenge the capacity of the ponds faster than the ponds can be predischarge monitored and subsequently batch discharged.

If water levels rise above safety limits that preserve dam integrity, then ponds must be discharged to prevent overflow or breaching.[3] The risk to the public and environment is far greater from a dam breach than from the normally low levels of contaminants that might be found in pond waters.

The actual decision process for managing pond operations and conducting pond and dam monitoring activities is too complex to be treated in this document. Detailed information can be found in the *Rocky Flats Environmental Technology Site Surface Water Pond Operations Plan* (POP; DOE 2005c, or its successor), and the *Rocky Flats Environmental Technology Site Emergency Response Plan for Rocky Flats Dams* (ERP; DOE 2005b, or its successor).

[3] Maximum discharge rate for earthen dams is generally one foot per day to achieve drawdown without inducing sloughing of the saturated sides of the dam.

Data Types and Frequencies:

The decision factors include safe pond capacity, actual pond elevation, current and projected flow rates into and out of the ponds, and several indicators of dam integrity, such as piezometer readings, inclinometer readings, and cracks or sloughs of embankment material. The information needs are as follows:

- Pond inflow rates into Ponds A-3, A-4, B-5, and C-2 (can be continuously monitored for daily to hourly averages with instantaneous measurement capability);[4]
- Pond elevations for Ponds A-3, A-4, B-5, C-2, and the East Landfill Pond (can be continuously monitored for daily to hourly averages with instantaneous measurement capability);
- Measurements from piezometers within dams (as an indication of water pore pressure in dam structures);
- Visual inspections of dam integrity;
- Results from the expert system that rates the above inputs to determine whether to release water from a dam despite water quality (the POP and the ERP [or their successors] provide details that describes this logic);
- Pond discharge (outflow) rates from Ponds A-3, A-4, B-5, and C-2 (pumped or through outlets; daily to hourly averages with instantaneous measurement capability);
- Weather prediction (affects the weighting factors in the expert system);
- Dam inspections and observations;
- Annual Federal Energy Regulatory Commission (FERC) inspections;
- Crest monument movement monitoring; and,
- Inclinometer monitoring.

Boundaries:

Spatial: Inflows to and outflows from Ponds A-3, A-4, B-5, and C-2 are used in decision making. Each individual dam and the water volumes in each pond are included in decision making. Only terminal ponds (A-4, B-5, and C-2 in the North Walnut Creek, South Walnut Creek, and Woman Creek drainages, respectively) are normally operated to retain and batch release water off Site. (Woman Creek normally flows around Pond C-2, through an artificial diversion. However, Pond C-2 is directly discharged in the natural drainage of Woman Creek and may receive overflow from Woman Creek during extreme flood conditions.)

Temporal: Information is collected at varying intervals based on the pond conditions and rate of change of the specific parameter. Daily or more frequent dam piezometer data, hourly inflow and outflow data, and hourly to daily pond level data are all transmitted by telemetry. Most decisions are made Monday through Friday on a daily basis; however, during a crisis situation, hourly

[4] Critical measurements, such as pond inflow rates and elevations, require hourly monitoring capability, even though daily monitoring may be adequate for a portion of the year.

decisions may be made seven days a week. The Site also maintains instantaneous measurement capability for all telemetry data that can be accessed both on and off Site.

Monitoring Requirements:

Monitoring requirements to safely operate the dams are presented in Table 2−2.

The actual decision process for managing pond operations and conducting pond and dam monitoring activities is too complex to be treated in this document. Detailed information can be found in the POP (DOE 2005c, or its successor), and the ERP (DOE 2005b or its successor). The following general decisions must be made on a continuous basis for Ponds A-3, A-4, B-5, and C-2. A series of simultaneous equations are solved via an expert system framework to consider actions associated with modeled action levels.

Decision Statements:

IF Predischarge water quality analytical results meet applicable standards to protect downstream water users, and the dam is at pond operations Action Level 3 or less (determined by piezometer readings [water level in dam structure], dam inspections, pool level, and inflow data)—

THEN The Site will discharge water from the pond.

IF A pond reaches Action Level 4 (i.e., exceeds its safe capacity based on data including piezometer readings, dam inspections, pool level, and inflow data)—

THEN The Site will release water (without waiting for predischarge analytical results; however, applicable POC monitoring will occur) from the pond at a draw-down rate of 1 foot per day with notification to specified agencies.

IF A pond reaches Action Level 5 (spillway overflow occurring or overtopping expected or breaching possible based on data including piezometer and inclinometer [measures the change in a slope, providing early warning of a potential dam failure] readings, dam inspections, pool level, and inflow data)—

THEN The Site will release water (without waiting for predischarge analytical results; however, applicable POC monitoring will occur) from the pond at a draw-down rate greater than 1 foot per day. Notifications will be made as required.

IF Routine or emergency dam inspections, inclinometer readings, piezometer readings, or other monitoring activities reveal changed conditions affecting the structural integrity of a dam—

THEN The Site will notify the Colorado State Engineer and other agencies, as required by the Code of Colorado Regulations (CCR) (2 CCR 402-1, Rules 14 and 15) and Colorado Revised Statutes (CRS) (CRS 37-87-102 through 115), and develop alternatives, as necessary and appropriate, to correct the identified problem.

Table 2–2. Monitoring Requirements for Safe Operation of Dams Under Action Level Conditions

Data Types Monitored	**Dam A-1**	**Dam A-2**	**Dam A-3**	**Dam A-4**	**Dam B-1**	**Dam B-2**	**Dam B-3**	**Dam B-4**	**Dam B-5**	**Dam C-1**	**Dam C-2**	**Land-fill**
Inflow rate (telemetry measurement)	—	—	24/day [GS13]	24/day [GS12]	—	—	—	—	24/day [GS10]	—	24/day [SW027]	—
Inflow rate (field measurement)	—	—	—	—	—	—	—	—	—	—	—	—
Discharge rate (telemetry measurement)	—	—	24/day [GS12]	24/day [GS11]	—	—	—	—	24/day [GS08]	—	24/day [GS31]	—
Discharge rate (field measurement during discharge)	2/day	2/day	2/day	2/day	2/day	2/day	—	—	2/day	—	2/day	2/day
Pond elevation (telemetry measurement)	—	—	24/day	24/day	—	—	—	—	24/day	—	24/day	24/day
Pond elevation (field measurement)	1/month	1/month	1/week	1/week	1/month	1/month	—	—	1/week	—	1/month	1/month
Piezometers (telemetry measurement)	—	—	4/day	4/day	—	—	—	—	4/day	—	4/day	4/day
Piezometers (field measurement)	—	—	1/month	1/month	1/month	—	1/month	—	1/month	—	1/month	1/month
Routine dam observation	1/month	1/month	1/month	1/month	1/month	1/month	1/month	1/month	1/month	1/month	1/month	1/month
Detailed dam inspection	1/2 years	1/year	1/year	1/year	1/2 years	1/2 years	1/2 years	1/2 years	1/year	1/2 years	1/year	1/year
FERC and DOE dam inspection	—	1/2 years	1/2 years	1/year	—	—	—	—	1/year	—	1/year	1/2 years
Inclinometer (field measurement)	—	—	—	2/year	—	—	—	—	2/year	—	2/year	—
Crest monument movement (field measurement)	—	—	—	2/year	—	—	—	—	2/year	—	2/year	—
Use of computer expert system to predict pond filling and discharge events (using data from telemetry and field measurement)	1/week	1/week	1/week	1/week	1/week	1/week	—	—	1/week	—	1/week	1/week

Notes:
Specific automated gauging station locations are, for example, shown as: [GS12]
– = Not applicable
DOE = U.S. Department of Energy
FERC = Federal Energy Regulatory Commission

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - LM/Stoller determines the frequency and type of monitoring specified as appropriate to identify any structural problems in a timely manner consistent with standard industry practices and applicable regulations.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - Does not apply.

2.2.2 Ad Hoc Monitoring

The Site and agencies monitor surface waters on an ad hoc basis for a variety of reasons. This monitoring may or may not be used in decision-making processes, but it has been frequently requested by DOE-RFPO, cities, and regulatory agencies. The Surface Water IMP Working Group anticipated that these parties would continue to request such ad hoc monitoring in the future, regardless of whether funding is allocated for that purpose.

This monitoring will not always require sample analyses. In some cases, only flow measurement will be needed. Some examples that may warrant ad hoc monitoring include

- Major precipitation events that disrupt routine pond predischarge monitoring and discharge schedules;
- Community assurance monitoring at the request of downstream cities and DOE;
- Unanticipated changes in regulatory permits, agreements, or funding; and
- Anticipated but unfunded changes in permits or agreements.

2.2.2.1 No Name Gulch Flow Monitoring

No Name Gulch is a small tributary to Walnut Creek. It lies north of the former IA and North Walnut Creek, comprising an area of approximately 260 acres. Flow in No Name Gulch is characterized by intermittent continuous periods of flow in the spring, with extended periods of no flow at other times of the year. During these dry periods, a significant precipitation event can result in short-term direct runoff periods. The Present Landfill also lies in the upper reaches of No Name Gulch. The Water Working Group requested flow monitoring at the downstream end of No Name Gulch to quantify contributions to Walnut Creek. As such, monitoring location GS33 will be maintained as a flow measurement location. The location of GS33 is shown on Figure 2−2.

Data Types and Frequencies:

- Continuous flow data at 15-minute intervals; and
- No samples will be collected for laboratory analysis.

Boundaries:

Spatial: Data collection limited to monitoring location GS33 on No Name Gulch at the confluence with Walnut Creek.

Temporal: Information is collected continuously using automated equipment.

Monitoring Requirements:

Monitoring requirements for No Name Gulch are presented in Table 2−3.

Table 2–3. No Name Gulch Automated Monitoring Location

Location Code	Location	Sample Collection	Field Data Collection	Primary Flow Measurement Device	Telemetry
GS33	No Name Gulch at confluence with Walnut Creek	None	Continuous flow data at 15-minute intervals	9.5-inch Parshall flume	Yes

Decision Statement:

No specific data evaluation is required. Flow data at GS33 will be collected for information purposes only and for relative comparisons to total Walnut Creek flows.

2.2.3 Indicator Parameter Monitoring for Assessment of Analytical Water quality Data

This objective provides for the collection of general water quality and quantity information to be used for various data assessments. Specifically, this objective outlines the current uses of parameters such as total suspended solids (TSS) and flow rate.

This monitoring objective is intended to collect indicator parameter data used to assess analytical measurements of constituents such as radionuclides and metals to determine whether stormwater discharges are affecting water quality. The targeted indicator parameters include TSS, precipitation, and flow rate. The collection of these data will also support evaluation of erosion control measures, design of water management options, investigations into actinide transport, assessment of statistically significant changes in water quality, and management decision making.

Data Types and Frequencies:

To evaluate actinides in conjunction with TSS, TSS would ideally be analyzed for all actinide samples collected at the locations covered by the other decision rules in this surface water section. However, sampling protocols (continuous flow-paced) often result in composite samples that are collected over periods exceeding the 7-day hold time for TSS analyses. Therefore, TSS cannot be analyzed for all composite samples but will be analyzed when possible.

To evaluate analytical constituents in conjunction with precipitation, precipitation will be monitored at eight locations across the Site. The location of precipitation gauges allows for the calculation of areal precipitation for any drainage area tributary to each monitoring location. Each of these stations is equipped with a continuously recording precipitation gauge.

To evaluate analytical constituents in conjunction with flow rate, flow is currently monitored at all automated monitoring locations at the Site. Each of these locations is equipped with a continuously recording flow-measurement device.

This decision rule does not limit the data uses to those given above. Evaluations may be determined for any data combinations as required. For example, assessments using flow and precipitation or precipitation and TSS, may be useful depending on the specific data evaluation.

Boundaries:

Spatial: Data may be acquired at any monitoring location either on- or off-Site.

Temporal: Sample must be analyzed within applicable hold times.

Monitoring Requirements:

The targets shown in Table 2−4 are partially redundant with other decision rule monitoring requirements, but are specified here to retain the independence and separability of the monitoring requirements for each decision rule.

Table 2–4. Annual Monitoring Targets (Number of Samples/Analyses) for Indicator Parameter Monitoring for Analytical Water quality Assessment

Monitoring Location	Analytical Analyses	TSS Analyses	Flow Measurement Frequency
All automated locations	As required by other decision rules	For all samples when meeting 7-day TSS hold-time requirement when also analyzing for Pu and Am	15 minutes

Notes:
The data collection shown above includes current parameters. Additional parameters may be added or deleted as needs arise.
Am = Americium
Pu = Plutonium
TSS = Total suspended solids

Decision Statement:

Table 2−5 outlines the anticipated or past data uses associated with this decision rule. This list provides examples of data uses; future data uses may be developed as needs arise. No specific decisions using these data are given here.

Table 2–5. Selected Data Uses of Indicator Parameter Monitoring for Analytical Water quality Assessment

Data Use	Targeted Parameters	Description
Rainfall-runoff relationships	Precipitation, flow rate, flow volume	Determination of hydrologic characteristics for specific drainage areas
Evaluation of TSS with flow rate	TSS, flow rate	Use of flow rate measurements to predict TSS concentrations
Assessment of actinide measurements	Actinides, TSS, flow rate	Determine if cause of unusual actinide measurement is likely due to Site conditions or extreme hydrologic conditions
Modeling	Flow rate, flow volume	Model design, calibration, and verification
BMP assessment	TSS, flow rate	Determine effectiveness of various erosion control measures
Land configuration	Flow rate, flow volume, TSS	Assess land configuration options: determine flow routing, size hydraulic components, assess sedimentation rates, design maintenance and operation protocols
Long-term stewardship	Flow rate, flow volume, TSS, actinides	Assess post-closure conditions

Notes:
BMP = Best management practice
TSS = Total suspended solids

2.2.4 Investigative Monitoring

When reportable water quality measurements are detected by surface water monitoring at POEs or POCs, additional monitoring may be required to identify[5] the source and evaluate for mitigating action pursuant to RFCA through the consultative process. This Investigative Monitoring objective is intended to provide upstream water quality information should reportable water quality values be detected at RFCA POEs or POCs. Data collection is generally limited to POE and POC AoIs and is intended to be discontinued once acceptable water quality has been demonstrated at POEs and POCs for an extended period.

Data collection upstream of POEs and POCs is not limited to the locations below. The Site may also elect to collect data using other methods, subject to the characteristics of the reportable water quality values and through the consultative process.

Data Types and Frequencies:

- Continuous flow data at 15-minute intervals;
- Continuous flow-paced composite samples at location-specific frequencies;
- Isotopic uranium (U) analytical results from GS05, GS13, and GS59; and
- Isotopic Pu, Am, and TSS analytical results from GS51 and SW018.

[5] Note that the term “identify” is used here to mean “locate.” Characterization is also implied.

Boundaries:

Spatial: Data collection limited to monitoring locations GS05 and GS59 on Woman Creek; GS13 and SW018 on North Walnut Creek; and GS51 on areas tributary to the SID.

Temporal: Data are collected continuously using automated equipment.

Monitoring Requirements:

Monitoring requirements are shown in Table 2−6 and Table 2−7.

Table 2–6. Investigative Surface Water Monitoring Locations

Location Code	Location Description	Sample Collection	Field Data Collection	Primary Flow Measurement Device	Telemetry
GS05	Woman Creek at western Site boundary	Flow-paced composites; isotopic U	Continuous flow data at 15-minute intervals	9-inch Parshall flume	Yes
GS13	North Walnut Creek just upstream of A-Series Bypass	Flow-paced composites; isotopic U	Continuous flow data at 15-minute intervals	6-inch Parshall flume	Yes
GS51	Drainage area south of 903 Pad/Lip tributary to the SID	Flow-paced composites; Pu, Am, TSS	Continuous flow data at 15-minute intervals	0.75-foot H-flume	Yes
GS59	Woman Creek 700 feet east of OLF	Flow-paced composites; isotopic U	Continuous flow data at 15-minute intervals	1.5-foot Parshall flume	Yes
SW018	North Walnut Creek tributary west of former Building 771 area	Flow-paced composites; Pu, Am, TSS	Continuous flow data at 15-minute intervals	1-foot H-flume	Yes

Notes:
Am = Americium
Pu = Plutonium
TSS = Total suspended solids
OLF = Original Landfill
SID = South Interceptor Ditch
U = Uranium

Table 2–7. Monitoring Targets (Annual Number of Composite Samples) for Investigative Monitoring Locations

Month	Number of Samples				
	GS05	GS13	GS51	GS59	SW018
October	0	0	1	0	1
November	1	1	0	1	0
December	0	0	0	0	0
January	0	1	0	0	1
February	1	0	0	0	0
March	1	1	1	2	0
April	3	2	3	3	2
May	1	1	1	1	1
June	0	0	1	1	1
July	1	1	1	0	1
August	0	1	0	0	1
September	0	0	0	0	0
Annual Total	8	8	8	8	8

Notes:
Total samples for all five stations = 40
Sample counts are targets; actual sample counts will depend on availability of surface water flow

Decision Statement:

IF Reportable water quality values are observed at a POE or POC (see Sections 2.4.1 and Section 2.5.2) for the applicable RFCA AoIs—

THEN Investigative monitoring data from an appropriate upstream location may be used to evaluate the reportable POE or POC values, subject to the consultative process.

IF No reportable water quality values are observed at a specific POE or POC (see Section 2.4.1 and Section 2.5.2) for the applicable RFCA AoIs for a period of 1 full year—

THEN Analysis of the collected sample(s) from the appropriate tributary upstream location(s) will be suspended; samples will continue to be collected and held for a period of 6 months for potential analysis should reportable water quality values subsequently be observed at a POE or POC (subject to the consultative process).

IF No reportable water quality values are observed at a specific POE or POC (see Section 2.4.1 and Section 2.5.2) for the applicable RFCA AoIs for a period of 5 consecutive years—

THEN Sample collection from the appropriate tributary upstream location(s) will be terminated; the ability to resume upstream sampling at these locations, or any other appropriate location, will be maintained should subsequent reportable water quality values be observed at a POE or POC (subject to the consultative process).

2.3 Industrial Area Monitoring Objectives

This section includes the monitoring objectives for decisions regarding the former IA.[6]

2.3.1 Performance Monitoring

2.3.1.1 Present Landfill

The objective of this section is to describe post-accelerated action surface water monitoring requirements necessary to determine the short- and long-term effectiveness of the remedy. These requirements were initially identified in the *Final Interim Measures/Interim Remedial Action (IM/IRA) for IHSS 114 and RCRA Closure of the RFETS Present Landfill*, "Appendix B: Post-Accelerated Action Monitoring and Long-Term Surveillance and Monitoring Considerations" (DOE 2004b), and finalized in the *Present Landfill Monitoring and Maintenance Plan and Post-Closure Plan* (PLF M&M Plan, DOE 2006c) including institutional controls, inspection and maintenance, and environmental monitoring. These requirements are specific to the accelerated actions described in the Present Landfill IM/IRA. Additionally, those requirements will ultimately be captured (along with post-closure care requirements from other accelerated actions at RFS) in post-closure regulatory documents, which may include the final CAD/ROD for RFS,

[6] In the surface water monitoring objectives, the term "Industrial Area" is intended to also include the 903 Pad, Original Landfill, Present Landfill, and the three ground water treatment systems (Mound, East Trenches, Solar Ponds).

and the post-closure regulatory agreement. DOE and CDPHE have agreed to a covenant (DOE 2006b) specific to the Present Landfill which further defines institutional control requirements.

Post-closure controls, monitoring, and maintenance requirements for the cover described in the Present Landfill M&M Plan will be implemented at the Present Landfill. Some of those requirements are also the subject of the environmental covenant.

The following requirements consistent with Part 265.310(b) were imposed by the M&M Plan and covenant for the Present Landfill:

- Maintain the integrity and effectiveness of the final cover, including making repairs to the cover as necessary to correct the effects of settling, subsidence, erosion, or other events;
- Maintain and monitor the ground water monitoring system and comply with all other appropriate ground water monitoring requirements; and
- Prevent run-on and run-off from eroding or otherwise damaging the final cover.

The surface water monitoring requirements are discussed further below.

The landfill seep and ground water intercept system (GWIS) flow will be sampled at three influent streams to the treatment system and at the National Pollutant Discharge Elimination System (NPDES) outfall (treatment system effluent). The analytes that will be sampled for are listed in the *Present Landfill Monitoring and Maintenance Plan and Post-Closure Plan* (DOE 2006c).

The limits for the treatment system effluent are the surface water standards applicable for the receiving water as listed in RFCA Attachment 5, Table 1. After the cover is installed, monitoring of the influents to and effluent of the treatment system will be conducted quarterly until the first CERCLA review. A validated exceedance of an effluent limit will trigger an increase in monitoring to monthly for three consecutive months. Continued exceedances during the 3-month period will trigger consultation between the RFCA Parties to evaluate whether a change to the remedy is required, additional parameters need to be analyzed, or a different sampling frequency is required. If no exceedances are detected during the first CERCLA review period, then the monitoring frequency will change from quarterly to either semiannually or annually, based on the review of the data by the RFCA Parties.

During future CERCLA periodic reviews, the RFCA Parties will evaluate whether continued monitoring of the treatment system effluent is required beyond the yearly sampling required under the existing law.

If the effluent of the seep treatment system continues to exceed the established effluent limits, water in the East Landfill Pond will be sampled for the constituents that have been exceeded in the seep treatment system effluent. If the water in the East Landfill Pond exceeds the surface water standards applicable for the receiving water as listed in RFCA Attachment 5, Table 1, the RFCA Parties will be consulted to determine if further monitoring is required, if the water in the pond can continue to be allowed to overflow through the existing spillway at the East Landfill Pond, or some other water management strategy should be implemented.

Results from the GWIS sampling locations will be reported to the RFCA Parties on a quarterly basis. The RFCA Parties will periodically evaluate the data to determine if GWIS sampling should be discontinued.

Data Types and Frequencies:

- Quarterly grab samples for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), dissolved and total metals, and isotopic uranium (limited to constituents with surface water standards in RFCA Attachment 5) at the effluent of the treatment system (PLFSYSEFF) and the east end (outfall) of the East Landfill Pond (if required; PLFPONDEFF);
- Quarterly grab samples for VOCs, dissolved and total metals, and isotopic uranium (limited to constituents with surface water standards in RFCA Attachment 5) at the seep influent (PLFSEEPINF);
- Quarterly grab samples for VOCs, dissolved and total metals, nitrate/nitrite, and isotopic uranium (limited to constituents with surface water standards in RFCA Attachment 5) at the north and south GWIS influent (GWISINFNORTH and GWISINFSOUTH); and
- Quarterly manual flow measurement at the seep influent (PLFSEEPINF).

Boundaries:

Spatial:	Data collection limited to the monitoring locations listed in Table 2−8.
Temporal:	Instantaneous flow and grab samples are routinely collected quarterly; monthly if required.

Monitoring Requirements:

Monitoring requirements are shown in Table 2−8 and Table 2−9.

Decision Statement:

IF	Quarterly effluent (PLFSYSEFF) results are greater than surface water standards listed in the RFCA, Attachment 5, Table 1—
THEN	Sampling frequency will be increased to monthly for 3 consecutive months (increased sampling, other than the routine quarterly sampling, will be limited to the constituents that triggered the increased sampling frequency).
IF	Monthly effluent results continue to be greater than surface water standards listed in the RFCA, Attachment 5, Table 1 for 3 consecutive months—
THEN	Notify the RFCA parties and sample the East Landfill Pond for the constituents that were greater than the surface water standards during monthly sampling—
ELSE	Discontinue monthly sampling for the constituents that were less than the surface water standards.

IF	East Landfill Pond sampling results are greater than surface water standards listed in the RFCA, Attachment 5, Table 1—
THEN	Consult the RFCA parties to determine if further sampling is required, or if another water management strategy should be applied (IM/IRA)—
ELSE	Continue routine quarterly sampling for the constituents that were sampled in the East Landfill Pond.

Table 2–8. Present Landfill Surface Water Monitoring Locations

Location Code	Location Description	Sample Collection	Field Data Collection
PLFSEEPINF	Present Landfill seep influent to treatment system	Quarterly grabs; VOCs, isotopic U, metals	Quarterly manual flow measurement
GWISINFNORTH	North GWIS influent to manhole	Quarterly grabs; VOCs, isotopic U, metals, nitrate/nitrite	NA
GWISINFSOUTH	South GWIS influent to manhole	Quarterly grabs; VOCs, isotopic U, metals, nitrate/nitrite	NA
PLFSYSEFF	Present Landfill treatment system effluent	Quarterly grabs; VOCs, SVOCs, isotopic U, metals	NA
PLFPONDEFF	East Landfill Pond water near pond discharge location (east end)	Quarterly grabs, if required; VOCs, SVOCs, isotopic U, metals	NA

Notes:
GWIS = Ground water intercept system
NA = Not applicable
U = Uranium
VOCs = Volatile organic compounds
SVOCs = Semi-volatile organic compounds

Table 2–9. Present Landfill Monitoring Targets (Number of Samples/Analyses)

Location	VOCs, SVOCs, Metals, Isotopic U (RFCA Att. 5)	VOCs, Metals, Isotopic U, nitrate/nitrite (RFCA Att. 5)	VOCs, Metals, Isotopic U (RFCA Att. 5)	Annual Total Number of Samples
PLFSEEPINF	NA	NA	4	4
GWISINFNORTH	NA	4	NA	4
GWISINFSOUTH	NA	4	NA	4
PLFSYSEFF	4	NA	NA	4
PLFPONDEFF	if required	NA	NA	if required
Annual Totals	4	8	4	16

Notes:
NA = Not applicable
RFCA = *Rocky Flats Cleanup Agreement*
VOCs = Volatile organic compounds
SVOCs = Semi-volatile organic compounds

2.3.1.2 Original Landfill

The objective of this section is to describe post-accelerated action surface water monitoring requirements necessary to determine the short- and long-term effectiveness of the remedy. These requirements were initially identified in the *Draft Final IM/IRA of IHSS Group SW-2, IHSS 115,* *Original Landfill and IHSS 196, Filter Backwash Pond*, "Appendix B: Post-Accelerated Action Monitoring and Long-Term Surveillance and Monitoring Considerations" (DOE 2004c), and finalized in the *Final Landfill Monitoring and Maintenance Plan, Rocky Flats Environmental Technology Site, Original Landfill* (DOE 2006a), including institutional controls, inspection and maintenance, and environmental monitoring. These requirements are specific to the accelerated actions described in the Original Landfill IM/IRA. Additionally, those requirements will ultimately be captured (along with post-closure care requirements from other accelerated actions at RFS) in post-closure regulatory documents, which may include the final CAD/ROD for RFS, and the post-closure regulatory agreement.

Post-closure controls, monitoring, and maintenance requirements for the cover described in the Original Landfill M&M Plan will be implemented at the Original Landfill.

The following requirements consistent with Part 265.310(b) were imposed by the M&M Plan for the Original Landfill:

- Maintain the integrity and effectiveness of the final cover, including making repairs to the cover as necessary to correct the effects of settling, subsidence, erosion, or other events;
- Maintain and monitor the ground water monitoring system and comply with all other appropriate ground water monitoring requirements; and
- Prevent run-on and run-off from eroding or otherwise damaging the final cover.

The surface water monitoring requirements are discussed further below.

Surface water in Woman Creek will be sampled both upstream (GS05) and downstream (GS59) of the Original Landfill. The analytes that will be sampled for are detailed in the *Final Landfill Monitoring and Maintenance Plan, Rocky Flats Environmental Technology Site, Original Landfill* (DOE 2006a).

Data Types and Frequencies:

- Flow-paced composite samples for isotopic uranium and dissolved and total metals (limited to constituents with surface water standards in RFCA Attachment 5) at GS05 and GS59;
- Quarterly grab samples for VOCs (limited to constituents with surface water standards in RFCA Attachment 5) at GS05 and GS59; and
- Continuous flow measurement for flow-paced sampling at GS05 and GS59.

Boundaries:

Spatial: Data collection limited to surface water monitoring locations listed in Table 2−10.

Temporal: Flow and continuous flow-paced samples are collected continuously using automated equipment; grab samples are collected quarterly.

Monitoring Requirements:

Monitoring requirements are shown in Table 2−10 and Table 2−11.

Table 2–10. Original Landfill Surface Water Monitoring Locations

Location Code	Location Description	Sample Collection	Field Data Collection	Primary Flow Measurement Device	Telemetry
GS05	Woman Creek at western Site boundary	Flow-paced composites (isotopic U, metals) and grabs (VOCs)	Continuous flow data at 15-minute intervals	9-inch Parshall flume	Yes
GS59	Woman Creek 700 feet east of Original Landfill	Flow-paced composites (isotopic U, metals) and grabs (VOCs)	Continuous flow data at 15-minute intervals	1.5-foot Parshall flume	Yes

Notes:
U = Uranium
VOCs = Volatile organic compounds

Table 2–11. Original Landfill Monitoring Targets (Number of Samples/Analyses)

Month	GS05[a] Isotopic Uranium/ Metals	GS59[a] Isotopic Uranium/ Metals	GS05 and GS59 VOCs	Total Number of Samples
October	0	0	1 each	2
November	1	1	0	2
December	0	0	0	0
January	0	0	1 each	2
February	1	0	0	1
March	1	2	0	3
April	3	3	1 each	8
May	1	1	0	2
June	0	1	0	1
July	1	0	1 each	3
August	0	0	0	0
September	0	0	0	0
FY Totals	8	8	4 each	24

[a]Collection frequency is based on Investigative Monitoring targets (Section 2.2.4). All investigative data will be used for the Original Landfill evaluation (the Original Landfill IM/IRA only requires quarterly samples for decision making).
Notes:
FY = Fiscal year
IM/IRA = Interim Measures/Interim Remedial Actions
VOCs = Volatile organic compounds

Decision Statement:

IF Quarterly mean concentrations at downstream location GS59 are greater than surface water standards listed in the RFCA, Attachment 5, Table 1,

AND Quarterly mean concentrations at downstream location GS59 are greater than quarterly mean concentrations at upstream location GS05—

THEN Sampling frequency will be increased to monthly for 3 consecutive months for the constituents that were greater than the surface water standards during quarterly sampling.

IF	Quarterly mean concentrations for monthly sampling at downstream location GS59 are greater than surface water standards listed in the RFCA, Attachment 5, Table 1,
AND	Quarterly mean concentrations for monthly sampling at downstream location GS59 are greater than quarterly mean concentrations for monthly sampling at upstream location GS05—
THEN	Consult the RFCA parties to determine whether a change in the remedy is required, additional parameters need to be analyzed, or a different sampling frequency is required—
ELSE	Discontinue monthly sampling.

2.3.1.3 Passive Ground Water Treatment Systems: Mound Site, East Trenches, and Solar Ponds Plume Treatment Systems

This section describes surface water monitoring associated with ground water decisions.

Contaminated ground water is intercepted and treated in three areas of the Site. The ground water intercept trenches are similar to a French drain with an impermeable membrane on the downgradient side. Ground water entering the trench is routed through the drain pipe into a treatment cell, where it is treated and discharged to surface water.

The three systems include the Mound Site Plume Treatment System (MSPTS), East Trenches Plume Treatment System (ETPTS), and Solar Ponds Plume Treatment System (SPPTS). The MSPTS was installed in 1998, and the other two were installed in 1999. Each system features at least two sample collection points that enable the collection of, at a minimum, untreated influent entering the treatment cells and treated effluent exiting the cells. While these samples may not strictly represent ground water, the monitoring of these systems is included in the Ground water Monitoring section of the IMP. Monitoring decisions also depend on surface water quality at designated "performance monitoring" locations downgradient of the discharge area of each treatment system. Because the associated DQOs support the ground water treatment systems, these surface water locations are addressed in detail in the Ground Water Monitoring section. The details regarding surface water data collection are duplicated in this Surface Water Monitoring section for completeness.

Mound Site Plume Treatment System (MSPTS)

Data Types and Frequencies:

- Semiannual grab samples for VOCs at GS10.

Boundaries:

Spatial: Data collection limited to surface water monitoring location GS10.

Temporal: Grab samples are collected semiannually.

Monitoring Requirements:

Monitoring requirements are shown in Table 2−12 and Table 2−13.

Table 2–12. MSPTS Surface Water Monitoring Locations

Location Code	Location Description	Sample Collection	Field Data Collection	Primary Flow Measurement Device	Telemetry
GS10	South Walnut Creek just upstream of B-Series Bypass	Grabs; VOCs	Continuous flow data at 15-minute intervals	9-inch Parshall flume	Yes

Notes:
VOCs = Volatile organic compounds

Table 2–13. MSPTS Monitoring Targets (Number of Samples/Analyses)

Sample Frequency	GS10 VOCs
Semiannual	2
FY Totals	2

Notes:
FY = Fiscal year
VOCs = Volatile organic compounds

Decision Statement:

Specific data evaluation is presented in the Ground Water Monitoring section. Details regarding data evaluation and reporting can be found in Section 3.3.10.

East Trenches Plume Treatment System (ETPTS)

Data Types and Frequencies:

- Semiannual grab samples for VOCs at POM2.

Boundaries:

Spatial: Data collection limited to surface water monitoring location POM2.

Temporal: Grab samples are collected semiannually.

Monitoring Requirements:

Monitoring requirements are shown in Table 2−14 and Table 2−15.

Table 2–14. ETPTS Surface Water Monitoring Locations

Location Code	Location Description	Sample Collection	Field Data Collection	Primary Flow Measurement Device	Telemetry
POM2	South Walnut Creek at Pond B-4 outlet	Grabs; VOCs	NA	NA	No

Notes:
NA = Not applicable
VOCs = Volatile organic compounds

Table 2–15. ETPTS Monitoring Targets (Number of Samples/Analyses)

Location	VOCs	Annual Number of Samples
POM2	Semiannual	2

Notes:
VOCs = Volatile organic compounds

Decision Statement:

Specific data evaluation is presented in the Ground Water Monitoring section. Details regarding data evaluation and reporting can be found in Section 3.3.10.

Solar Ponds Plume Treatment System (SPPTS)

Data Types and Frequencies:

- Flow-paced composite samples for isotopic uranium at GS13;
- Semiannual grab samples for total uranium at SPP DISCHARGE GALLERY;
- Semiannual grab samples for nitrate at GS13 and SPP DISCHARGE GALLERY; and
- Continuous flow measurement for flow-paced sampling at GS13.

Boundaries:

Spatial: Data collection limited to surface water monitoring locations SPP DISCHARGE GALLERY and GS13.

Temporal: Flow and continuous flow-paced samples are collected continuously using automated equipment; grab samples are collected semiannually.

Monitoring Requirements:

Monitoring requirements are shown in Table 2−16 and Table 2−17.

Table 2–16. SPPTS Surface Water Monitoring Locations

Location Code	Location Description	Sample Collection	Field Data Collection	Primary Flow Measurement Device	Telemetry
SPP DISCHARGE GALLERY	SPPTS discharge point to North Walnut Creek	Grabs (total U, nitrate)	NA	NA	No
GS13	North Walnut Creek just upstream of A-Series Bypass	Flow-paced composites (isotopic U) and grabs (nitrate)	Continuous flow data at 15-minute intervals	6-inch Parshall flume	Yes

Notes:
NA = Not applicable
SPPTS = Solar Ponds Plume Treatment System
U = Uranium

Table 2–17. SPPTS Monitoring Targets (Number of Samples/Analyses)

Month	GS13[a] Isotopic Uranium	SPP DISCHARGE GALLERY Total Uranium (semiannual)	GS13 and SPP DISCHARGE GALLERY Nitrate (semiannual)	Total Number of Samples
October	0	1	1	2
November	1	0	0	1
December	0	0	0	0
January	1	0	0	1
February	0	0	0	0
March	1	0	0	1
April	2	1	1	4
May	1	0	0	1
June	0	0	0	0
July	1	0	0	1
August	1	0	0	1
September	0	0	0	0
FY Totals	8	2	2	12

[a]Collection frequency is based on Investigative Monitoring targets (Section 2.2.4). All investigative data will be used for the SPPTS evaluation (only semiannual samples are required for decision making).
Notes:
FY = Fiscal year SPPTS = Solar Ponds Plume Treatment System

Decision Statement:

Specific data evaluation is presented in the Ground Water Monitoring section. Details regarding data evaluation and reporting can be found in Section 3.3.10.

2.3.1.4 Individual Hazardous Substance Site (IHSS) 118.1

Also monitored in support of ground water objectives is SW018, which is located in the unnamed tributary to North Walnut Creek downgradient (west-northwest) of IHSS 118.1. This IHSS was identified because of historical spills of carbon tetrachloride. The IHSS was remediated via source removal in 2004, but the associated plume of VOC-contaminated ground water persists. To assess whether this plume is impacting surface water, SW018 is monitored for VOCs.

Decisions associated with this location are similar to those for Area of Concern (AOC) wells (see Section 3.3.9.1, Figure 3−3). See Appendix B for summary information on monitoring requirements.

Data Types and Frequencies:

- Semiannual grab samples for VOCs at SW018.

Boundaries:

Spatial: Data collection limited to surface water monitoring location SW018.

Temporal: Grab samples are collected semiannually.

Monitoring Requirements:

Monitoring requirements are shown in Table 2−18 and Table 2−19.

Table 2–18. IHSS 118.1 Surface Water Monitoring Locations

Location Code	Location Description	Sample Collection	Field Data Collection	Primary Flow Measurement Device	Telemetry
SW018	North Walnut Creek tributary west of former Building 771 area	Grabs (VOCs)	Continuous flow data at 15-minute intervals	1-foot H-flume	Yes

Notes:
VOCs = Volatile organic compounds

Table 2–19. IHSS 118.1 Monitoring Targets (Number of Samples/Analyses)

Sample Frequency	SW018 VOCs
Semiannual	2
FY Totals	2

Notes:
FY = Fiscal year
VOCs = Volatile organic compounds

Decision Statement:

Specific data evaluation is presented in the Ground Water Monitoring section. Details regarding data evaluation and reporting can be found in that section.

2.3.1.5 CDPHE Performance Monitoring for Mound and East Trenches Plume Treatment Systems

The Mound and East Trenches ground water contamination plumes contain VOCs. Ground water collection and treatment systems have been installed, and the treatment appears to be effective. However, it is possible that some contaminated ground water either was already downgradient of the collection systems before they were installed, or that some ground water may be bypassing the collection trenches. There is no in-stream monitoring specified in the Decision Documents for these systems that can either verify or disprove this. To verify that stream standards are being attained, monitoring for VOCs will be done in South Walnut Creek at POM2 and POM3. RFS will also collect samples at POM2 and POM3 in coordination with CDPHE.

Data Types and Frequencies:

Monitoring will be done for VOCs on a semiannual basis at the same time as sampling of the Sentinel ground water wells in the area (95099, 95199, 95299, 23296, and TH046992). The VOC testing will be done such that all VOCs known to exist within the plumes will be included in the analyses.

Boundaries:

Spatial: South Walnut Creek in the immediate vicinity of the location where the ground water contamination plumes may be intersecting the stream (POM2 and POM3).

Temporal: Until it has been demonstrated that in-stream and stream-adjacent ground water VOC concentrations are below stream standards for a period of at least 3 consecutive years, and the potential for further stream impact is demonstrated to be negligible.

Decision Statement:

IF VOC concentrations exceed stream standards—
THEN The monitoring frequency and number of sampling locations may be increased. Further investigation of in-stream concentrations and the cause for the high concentrations will be performed.

IF VOC concentrations are lower than stream standards, but significantly higher than the concentrations found at other locations on RFS—
THEN Further investigation of in-stream concentrations and the cause for the unusually high concentrations will be considered.

Acceptable Decision Errors:

The contaminant sources being investigated are ground water plumes. If the plumes intersect the stream, a variation in in-stream concentrations will likely be due to seasonal hydrologic conditions. Therefore, semiannual sampling should be sufficient to assess the full range of in-stream concentrations.

Monitoring Requirements:

Grab samples will be collected on a semiannual basis at POM2 and POM3 at the same time that the Sentinel ground water wells in the area are sampled.

2.3.1.6 CDPHE Performance Monitoring for the Solar Pond Plume Treatment System

The Solar Ponds ground water contamination plume contains high levels of nitrates and U, and lower concentrations of several other metals. Ground water collection and treatment systems have been installed, and the treatment appears to be effective. However, it is possible that some contaminated ground water either was already downgradient of the collection system before it was installed, or that some ground water may be bypassing the collection trench.

While RFS monitors in-stream nitrate and U concentrations, CDPHE will perform in-stream monitoring for metals. These data will be used to verify that stream standards are being attained.

Data Types and Frequencies:

Monitoring will be done for metals on an as needed basis (with a goal of semiannually at the same time as Sentinel wells in the area [51605 and 70299]). Analyses will be performed for these metals: dissolved Ag, Cu, Mn, Ni, and Se; and total As, Be, Cd, Cr, Fe, and Li. Also, to obtain at least a minimal assessment of hardness—which is required for metals standards calculations—hardness may be monitored at GS13.

Boundaries:

Spatial: North Walnut Creek in the immediate vicinity of the location where the Solar Ponds Plume may be intersecting the stream (GS13 and the SPP DISCHARGE GALLERY).

Temporal: Until it has been demonstrated that in-stream and stream-adjacent ground water nitrate, U, and metals concentrations are below stream standards for a period of at least 3 consecutive years, and the potential for further stream impact is demonstrated to be negligible.

Decision Statement:

IF Metals concentrations exceed stream standards—
THEN The monitoring frequency and number of sampling locations may be increased. Further investigation of in-stream concentrations and the cause for the high concentrations will be performed.

Acceptable Decision Errors:

The contaminant source being investigated is a ground water plume. If the plume is intersecting the stream, any variation in in-stream concentrations will likely be due to seasonal hydrologic conditions. Therefore, semiannual sampling should be sufficient to assess the full range of in-stream concentrations.

Monitoring Requirements:

Grab samples will be collected on a semiannual basis at monitoring locations SW093 and GS13.

2.4 Monitoring Objectives for Industrial Area Discharges to Ponds

This section addresses monitoring of surface water before it arrives in the terminal ponds (i.e., surface waters running off of the former IA to waters upstream of the terminal ponds). These discharges are the major transport pathways available for contaminants leaving the former IA. Merely monitoring the terminal pond discharges is not adequate to protect water quality above the terminal ponds (in compliance with RFCA requirements), or to detect changes in contaminant runoff from within the former IA.

2.4.1 Point of Evaluation Monitoring

This monitoring objective deals with POE surface water monitoring for determination of conformance with RFCA action levels. RFCA provides specific criteria for virtually every possible contaminant for the main stream channels flowing to the A-Series, B-Series, and C-2 Ponds. In Table A−1 (see Appendix A), the DQO team identified a subset of those contaminants that are of sufficient interest to warrant monitoring. Figure 2−2 shows the monitoring points used for various decisions.

Responses to exceedances at POEs are different than those associated with contaminated runoff before it reaches the ponds or after it leaves the terminal ponds. Monitoring upgradient of the ponds is designed to detect new contaminant sources within the former IA. Downstream, water below the terminal ponds is monitored at POCs to determine compliance with RFCA standards and action levels. This subsection of the document deals with POE monitoring above the ponds for compliance with RFCA action levels.

Historical data indicate that several regulated contaminants may exceed their RFCA action level criteria at the designated POEs. Such reportable values will require source evaluation and the development of a mitigation plan, if appropriate. The initial response to these exceedances might be to evaluate investigative monitoring data, perform special monitoring tailored to the specific investigation, and take action upstream of the ponds to protect the ponds from contaminant sources that caused such exceedances.

Data Types and Frequencies:

- RFCA AoIs, as sampled for at the POEs (see Table A−1 in Appendix A). POE monitoring will be performed only at GS10, SW027, and SW093 (see Figure 2−2);
- Isotopic Pu, Am, and U at all POEs;
- Total Be and Cr, dissolved Cd and Ag, hardness, at all POEs;
- Continuous flow data at 15-minute intervals; and
- Sampling for AoIs at POEs is performed by collecting continuous flow-paced composite samples.

Boundaries:

Spatial: Data collection is limited to POE monitoring locations GS10, SW027, and SW093.

Temporal: Data are collected continuously using automated equipment.

Monitoring Requirements:

The recommended monitoring design for the Site is to take samples as specified in Table 2−20, and analyze each sample for the POE AoIs specified in Table A−1 of Appendix A, attempting to take no less than one sample per quarter and no more than four sequential samples per month from each of the four monitoring points.

Table 2−20 presents a revised number of samples per month for the POEs. The original recommendations from statisticians at the Pacific Northwest National Laboratory (PNNL) were updated using recent flow data and expected post-closure discharge volumes to collect more appropriate numbers of samples each month.

Table 2–20. Monitoring Targets (Annual Number of Composite Samples) for POEs

Month	Number of Samples			
	SW093	GS10	SW027	Totals
October	1	1	0	2
November	1	1	0	2
December	1	1	1	3
January	1	0	0	1
February	1	1	0	2
March	2	2	1	5
April	4	4	3	11
May	3	3	2	8
June	2	2	1	5
July	1	2	0	3
August	2	2	1	5
September	1	1	0	2
Annual Total	20	20	9	49

Where there is no significant flow, there may be no samples completed within a 30-day period, and where the flows, loads, and variability are expected to be higher, numbers of composite samples are also higher. Note that flow-paced monitoring will continue during dry periods, even though flows may be so low that it takes more than 30 days to fill the composite sample container.

Moving averages are to be calculated for the preceding period, verified by additional analyses at the discretion of the monitoring organization, and formally reported to the DOE-RFPO within 30 days of gaining knowledge that an exceedance of action levels may have occurred (i.e., within 30 days of receiving a high analytical result). This 30-day period allows time for verification analyses after the monitoring organization receives information that an exceedance may have occurred before formal notification to DOE-RFPO of an actual exceedance is required. RFCA requires that DOE-RFPO inform regulators within 15 days of DOE-RFPO gaining knowledge that an exceedance (verified) has occurred. During this 45-day period between first indication and formal notification to regulators, DOE-RFPO may initiate discretionary mitigating action. The delay interval will prevent undue reporting when the initial high result is not confirmed by subsequent monitoring. Informal communications between the Parties are intended during the confirmation interval.

Decision Statement:

IF The volume-weighted 12-month rolling average[7] for any radionuclide AoI, as represented by samples from the specified RFCA POEs (GS10, SW027, and SW093), exceeds the appropriate RFCA action level—

[7] The 12-month rolling average for the last day of a particular month is calculated as a volume-weighted average of a “window” of time containing the previous 12 months. Each 12-month “window” includes daily discharge volumes (measured at the location with a flow meter) and daily activities (from the sample carboy in place at the end of that day). Therefore, there are twelve 12-month rolling averages for a given calendar year. Days with no flow or no analytical result, either due to failed laboratory analysis or NSQ for analysis, are not included in the average. When no flow has occurred in the last 12 months, no 12-month rolling average is reported.

THEN	RFS must notify EPA and CDPHE, evaluate for source location, and implement mitigating action[8] if appropriate.[9]
IF	The 85th percentile of the volume-weighted 30-day moving averages[10] of a given calendar year for any metals AoI, as represented by samples from the specified RFCA POEs (GS10, SW027, and SW093) exceeds the appropriate RFCA action level—
THEN	RFS must notify EPA and CDPHE, evaluate for source location, and implement mitigating action[8] if appropriate.[9]

2.5 Monitoring Objectives for Terminal Retention Pond Discharges and Water Leaving RFS

This section covers all surface water monitoring in streams leaving the eastern Site boundary (Indiana Street). This water is first monitored prior to discharge from the terminal ponds. Monitoring for RFCA compliance takes place at the terminal pond outfalls, and in both Woman and Walnut Creeks, near Indiana Street (RFCA POCs). Additional non-POC monitoring at Indiana Street was identified by the working group and is described at the end of this section.

2.5.1 Predischarge Monitoring

While pond predischarge monitoring over the last 3 years has revealed parameters exceeding stream standards, follow-up sampling with either additional grab samples or at downstream continuous monitoring stations has shown that the quality of the pond release as a whole was well within acceptable quality limits. In almost all cases, the pond sampling has shown levels of the parameters monitored to be well below a level of concern.

Because of the level of public concern about radionuclides, and the potentially extensive and costly consequences of releasing high levels of radionuclides in a pond discharge, "rush" sampling for radionuclides will be continued.

Samples should represent the water to be discharged (i.e., grab samples should be depth integrated where applicable, and addition of water to the discharge should be minimized after the grab sample is taken). If CDPHE believes that the first sample is not representative of the discharge, CDPHE may request, and the Site will provide, one additional predischarge sample if the discharge has not yet begun, or a during-discharge sample if the discharge is not yet complete. However, because of dam safety, the Site has sole discretion to determine the schedule

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[8] Mitigating action may include, but not be limited to, the following examples: 1) immediate action to halt a discharge or contain a spill; or 2) use of additional data collection to seek out and mitigate upstream contaminant sources.

[9] RFCA may actually specify consequences for an exceedance of any action level (not just those for AoIs) at any location within the segment (not just at the consensus monitoring points). This decision rule presents the consensus decision rule that drives our monitoring activities. It is an implementation, rather than a reiteration, of RFCA.

[10] The 30-day average for a particular day is calculated as a volume-weighted average of a "window" of time containing the previous 30-days that had flow. Each day has its own discharge volume (measured at the location with a flow meter) and activity (from the sample carboy in place at the end of that day). Therefore, there are 365 30-day moving averages for a location that flows all year. At locations that have intermittent flows, 30-day averages are reported as averages of the previous 30 days of greater than zero flow. For days where no activity is available, either due to failed laboratory analysis or NSQ for analysis, no 30-day average is reported.

for discharges, independent of an action the State may take with regard to predischarge monitoring. If the predischarge monitoring suggests an exceedance of a contaminant that is also monitored by flow-paced methods, the Parties recognize that the flow-paced methods would be more representative of the discharge compliance status.

It was the initial intention of the Parties that, for predischarge monitoring, the Site would perform the sample collection and CDPHE would perform the laboratory analysis and reporting functions of the completed analytical data. Routinely, the Site will collect and provide analytical data for selected radionuclides and organic constituents, as the CDPHE laboratory is sometimes unable to complete these analyses in the time frame necessary for optimum pond discharge operations.

Data Types and Frequencies:

A total of about six to eight predischarge samples will be taken annually from the ponds in the Walnut Creek drainage. One sample per year is expected to be taken from Pond C-2 in the Woman Creek drainage. CDPHE will analyze the samples for gross alpha and gross beta activity, Am, Pu, total U, selected metals, and selected water quality parameters. This predischarge monitoring is limited to Ponds A-4, B-5, and C-2, or other upstream pond functioning as a terminal pond (e.g., Pond A-3 during construction in Pond A-4). Samples are intended to be taken far enough in advance of the discharge so that isolation, containment, flow-paced compliance monitoring (at the terminal pond outfall POCs), or other actions can be taken to mitigate an exceedance, but near enough to the time of discharge that the sample is representative of the discharge. It is the intent of all Parties that sampling will be performed so that results are known prior to discharge.

Monitoring Requirements:

Monitoring analyses to be performed by the Site are shown in Table 2−21. The Site selected EPA Method 624 for volatile organic analysis (VOA), based on technical evaluation of available VOA methods. This evaluation concluded that Method 624 is sufficient, both with respect to the range of compounds that can be detected and the accuracy of the method.

Table 2–21. RFS Predischarge Monitoring Targets (Number of Samples/Analyses)

Analytical Parameter	Average Analyses per Month
Volatile organic analyses (EPA Method 624)	0.6
Isotopic Pu/U/Am	0.6

Notes:
Am = Americium
Pu = Plutonium
U = Uranium

Monitoring analyses to be performed by CDPHE are shown in Table 2−22.

Table 2–22. CDPHE Predischarge Monitoring Targets (Number of Samples/Analyses)

Analytical Parameter	Average Analyses per Month
Gross alpha	0.6
Gross beta	0.6
Pu/Am	0.6
Total U	0.6
Selected metals	0.6
Selected water quality parameters	0.6

Note:
Numbers of analyses are based on expected pond discharge operations.
Am = Americium
Pu = Plutonium
U = Uranium

Decision Statement:

IF Predischarge monitoring results suggest apparent exceedances of the applicable stream standards—

THEN CDPHE may notify the Site of additional AoIs for that discharge.

- The Site would then perform flow-paced POC monitoring for the additional AoI(s) during the discharge, as part of the compliance monitoring (see Section 2.5.2); and
- The Site may evaluate other water management options, including but not limited to, treatment, storage, or disposal, rather than immediate discharge.

It should be noted that the results of predischarge monitoring can only indicate an apparent exceedance because

- The water sampled is impounded and not discharged at the time of sampling (the predischarge sampling protocol applies to water to be discharged); and
- The single grab predischarge sample does not necessarily reflect the expected water quality associated with an entire pond discharge.

If an apparent exceedance is suggested, DOE-RFPO has the responsibility to decide management alternatives. It is the intent of the parties that predischarge monitoring is not enforceable under RFCA, but it will be performed as a prudent management practice that the Parties endorse.

2.5.2 Point of Compliance Monitoring

RFCA provides specific standards for Walnut and Woman Creeks below the terminal ponds. These criteria and the responses to them are different than the criteria and actions associated with the POEs. This section deals only with monitoring discharges from the terminal ponds into Woman and Walnut Creeks and the additional points of compliance at Indiana Street. Terminal pond discharges will be monitored by POCs GS11, GS08, and GS31. Walnut Creek will be monitored at Indiana Street by POC GS03. Woman Creek will be monitored at Indiana Street by POC GS01. These locations are shown on Figure 2−2.

With the completion of the Woman Creek Reservoir, located just east of Indiana Street and operated by the city of Westminster, Woman Creek flows are detained in cells of the reservoir until the water quality has been assured by monitoring of Site discharges via Woman Creek at Indiana Street (at GS01). Reservoir water is then pumped from Woman Creek Reservoir into the Walnut Creek drainage below Great Western Reservoir.

In the past (prior to September 1997), most natural flows in Woman Creek were diverted to Mower Reservoir and did not exit the Site via Woman Creek. This is no longer the case; the Mower Ditch headgates have been upgraded, and water in Woman Creek will leave the Site via Woman Creek (at GS01) and enter the Woman Creek Reservoir. In the past, Pond C-2 (located off channel in the Woman Creek drainage) was sampled and then pumped to the off-Site Broomfield Diversion Ditch. Currently, the Site discharges Pond C-2 directly into Woman Creek (at GS31); the water then flows to the Woman Creek Reservoir.

Concern has been expressed that meeting for radiological parameters in Pond C-2 discharge does not adequately demonstrate that water leaving RFS via Woman Creek and entering the Woman Creek Reservoir is meeting the radiological standards. Other Woman Creek water (combined with Pond C-2 or flowing in the absence of any Pond C-2 water) will enter the Woman Creek Reservoir. This is the basis for setting an additional RFCA POC for Woman Creek at Indiana Street (GS01) for those radiological contaminants that could be directly attributable to the Site (i.e., not naturally occurring).

A similar point of compliance, GS03, was established at Walnut Creek and Indiana Street. Although the Walnut Creek drainage has not undergoing operational changes like those in Woman Creek, it is possible that contaminated overland runoff or Present Landfill flows may enter Walnut Creek below the terminal pond monitoring points (GS11 and GS08), yet upstream of Indiana Street.

Data Types and Frequencies:

- RFCA AoIs, as sampled for at the POCs (see Table A−2 in Appendix A). POC monitoring will be performed only at GS01, GS03, GS08, GS11, and GS31 (see Figure 2−2);
- Isotopic Pu, Am, and total U at all POCs;
- Source of the water sampled. Monitoring at Indiana Street POCs GS01 and GS03 calls for samples to be segregated based on water origin (natural creek flows or terminal pond discharges commingled with natural flows);
- Samples collected will be continuous flow-paced composites; and
- Flow-paced monitoring is maintained at all times for the five POCs, even though no samples are anticipated from terminal pond stations except during planned pond discharges.

Boundaries:

Spatial: Data collection is limited to POC monitoring locations GS01, GS03, GS08, GS11, and GS31.

Temporal: Data are collected continuously using automated equipment.

Monitoring Requirements:

The original terminal pond sampling protocols developed through the DQO process targeted three samples per batch discharge. For calendar years 1999 through 2004, Pond B-5 discharged 511 million gallons (Mgals) in 38 batches over a total of 507 days (approximately 1.0 million gallons per day [MGD]; including Wastewater Treatment Plant effluent). Similarly, Pond A-4 discharged 220 Mgals in 17 batches over a total of 185 days (approximately 1.2 MGD). Using the original DQO target, 114 composites would have been collected from Pond B-5 (one per 4.5 Mgals) and 51 composites would have been collected from Pond A-4 (one per 4.3 Mgals).

With physical completion, flow volumes are expected to decrease significantly. In addition, hydrologic modeling has suggested that in a typical year flow volumes to Pond B-5, Pond A-4, and Pond C-2 (as modeled at GS10, SW093, and SW027) would be 3.8, 16.7, and 0.5 Mgals, respectively. Therefore, initial targets for Pond B-5 will be one composite for every 250,000 gallons of discharge volume, for Pond A-4 targets will be one composite for every 1 Mgals, and for Pond C-2 targets will be one composite for every 100,000 gallons. Additionally, no more than one composite per day of discharge will be collected for logistical purposes. Although these targets represent an increase in overall sampling frequency, this higher frequency will be used until post-closure hydrologic and water quality conditions can be further evaluated. For annual planning purposes, 17 composites will be collected from Pond A-4, 15 composites from Pond B-5, and five composites from Pond C-2, resulting in the collection of 37 total composite samples (see Table 2−23). These numbers are not stated as requirements.

The Indiana Street POCs collect the same number of samples during discharges, plus additional samples from storm runoff and baseflow between discharges. GS01 will collect five samples for the expected Pond C-2 discharges, and storm runoff and baseflow samples based on average annual volumes. During storm runoff and baseflow, the target is one sample per 500,000 gallons, with a maximum of four samples during any 1 month (see Table 2−23).

GS03 will collect the targeted 32 samples during Pond A-4 and Pond B-5 discharges (GS03 will collect the same number of composite samples as the terminal pond POCs for each discharge). During storm runoff and baseflow periods between discharges, GS03 will target one sample every 10 days. The goal is to have three analytical results for any 30-day period for averaging purposes. The Site reserves the right to combine samples of the same flow pacing to save resources, as long as two sample results are available for any 30-day period. This sample frequency modification from original targets for GS03 is a result of sampling protocol changes due to the past occurrences of NSQ samples.

POC monitoring will be confined to samples taken from the terminal pond discharges at GS11, GS08, and GS31, and the Indiana Street monitoring stations (GS01 and GS03). Table 2−24 shows the associations between monitoring locations and station designators.

Table 2–23. POC Monitoring Targets (Number of Samples/Analyses)

Time Period	Pond A-4	Pond B-5	Pond C-2	Walnut Creek at Indiana Street	Woman Creek at Indiana Street	Total Number of Samples
During discharge	17	15	5	32	5	74
Storm and Baseflow						
October	NA	NA	NA	2	1	3
November	NA	NA	NA	2	2	4
December	NA	NA	NA	2	2	4
January	NA	NA	NA	2	2	4
February	NA	NA	NA	2	2	4
March	NA	NA	NA	2	4	6
April	NA	NA	NA	3	4	7
May	NA	NA	NA	1	4	5
June	NA	NA	NA	3	1	4
July	NA	NA	NA	2	1	3
August	NA	NA	NA	2	1	3
September	NA	NA	NA	2	1	3
FY Totals	17	15	5	57	30	124

Notes:
FY = Fiscal year
NA = Not applicable

Table 2–24. POC Monitoring Station Designators

POC	Monitoring Station Designators
Pond A-4	GS11
Pond B-5	GS08
Pond C-2	GS31
Walnut Creek at Indiana Street	GS03
Woman Creek at Indiana Street	GS01

Decision Statement:

IF The volume-weighted 30-day moving average[11] for any AoI, as represented by samples from the specified Indiana Street RFCA POCs (GS01 and GS03), exceeds the appropriate RFCA standard—

THEN RFCA requires that DOE-RFPO inform regulators within 15 days of DOE-RFPO gaining knowledge that an exceedance (verified) has occurred:

- Notify EPA, CDPHE, and either Broomfield or Westminster, whichever is affected;

[11] The 30-day average for a particular day is calculated as a volume-weighted average of a “window” of time containing the previous 30-days that had flow. Each day has its own discharge volume (measured at the location with a flow meter) and activity (from the sample carboy in place at the end of that day). Therefore, there are 365 30-day moving averages for a location that flows all year. At locations that monitor pond discharges or that have intermittent flows, 30-day averages are reported as averages of the previous 30 days of greater than zero flow. For days where no activity is available, either due to failed laboratory analysis or NSQ for analysis, no 30-day average is reported.

- Submit a plan and schedule to evaluate for source location, and implement mitigating action if appropriate; and
- The Site may receive a notice of violation.

IF The volume-weighted 12-month rolling average[12] for any AoI, as represented by samples from the specified terminal pond RFCA POCs (GS08, GS11, and GS31), exceeds the appropriate RFCA standard—

THEN RFCA requires that DOE-RFPO inform regulators within 15 days of DOE-RFPO gaining knowledge that an exceedance (verified) has occurred:

- Notify EPA, CDPHE, and either Broomfield or Westminster, whichever is affected;
- Submit a plan and schedule to evaluate for source location, and implement mitigating action if appropriate; and
- RFS may receive a notice of violation.

2.5.3 NON-POC Monitoring

2.5.3.1 CDPHE Non-POC Monitoring at Indiana Street

The State of Colorado has proposed to conduct this non-POC monitoring as a prudent management action, and it is the intent of the RFCA Parties that no enforcement action will be taken on the basis of this monitoring. Metals monitoring of flows coming from the IA is done by RFS at POEs that are located above the ponds on both Walnut Creek and Woman Creek. This monitoring should detect significant changes in metals loadings to surface waters from the IA.

The ponds themselves have likely accumulated sediments containing some metals. As RFS has progressed through closure, the hydrology of the stream/pond system has changed, with a gradual reduction in domestic water supply and wastewater effluent. The effect of both reduced flows (domestic water supply leakage and wastewater effluent) and reduced nutrient loading into the B-series ponds on stream/pond chemistry is unknown. Therefore, the monitoring described in this section will be done to ensure metal concentrations leaving RFS meet stream standards, and to provide an assessment of nutrients and physical parameters that might help explain any observed changes in metal concentrations over time.

Since the primary focus of this monitoring is to obtain an assessment of chemistry changes within the ponds, only pond releases will be monitored. And, as a practical matter, flows other than pond releases are only significant as a result of direct precipitation runoff, which will be difficult to assess accurately with only the grab sampling provided by CDPHE.

Data Types and Frequencies:

The complete list of analytes analyzed by CDPHE is given in Table 2−25. The real-time parameters will be collected by RFS. Note that pH and temperature are needed to calculate un-

[12] The 12-month rolling average for the last day of a particular month is calculated as a volume-weighted average of a “window” of time containing the previous 12 months. Each 12-month “window” includes daily discharge volumes (measured at the location with a flow meter) and daily activities (from the sample carboy in place at the end of that day). Therefore, there are twelve 12-month rolling averages for a given calendar year. Days with no flow or no analytical result, either due to failed laboratory analysis or NSQ for analysis, are not included in the average. When no pond discharge has occurred in the last 12 months, no 12-month rolling average is reported.

ionized ammonia. The sources of water at these locations during a sampling event must be identified.

Table 2–25. Non-POC Monitoring Requirements (Number of Samples/Analyses) at Indiana Street

Analyte	Number of Samples
Total ammonia	4
Nitrate/nitrite	4
Total phosphate as phosphorus (P)	4
Orthophosphate	4
Ag, Cu, Mn, Ni, Se (dissolved)	4
As, Be, Cd, Cr, Fe, Li (total)	4
Total hardness, as calcium carbonate ($CaCO_3$)	4
pH	Continuous 15-minute intervals
Temperature	Continuous 15-minute intervals
Conductivity	Continuous 15-minute intervals
Flow	Continuous 15-minute intervals

Notes:
Ag = Silver
Be = Beryllium
Cd = Cadmium
Cu = Copper
Li = Lithium
Ni = Nickel
Se = Selenium
As = Arsenic
$CaCO_3$ = Calcium carbonate
Cr = Chromium
Fe = Iron
Mn = Manganese
P = Phosphorus

Grab sample collection frequency will be as follows:

- Walnut Creek: As needed (with a goal of semiannually); and
- Woman Creek: As needed (with a goal of semiannually).

Non-POC monitoring is limited to samples taken from Walnut Creek at Indiana Street and Woman Creek at Indiana Street.

Decision Statement:

IF	Concentrations or loadings of specified contaminants in Woman Creek exceed their 95 percent upper tolerance levels (UTLs)—
THEN	CDPHE will notify RFS and the cities, and RFS may propose a change in ambient standards.

No formal action has been identified as being dependent on nutrient monitoring of Walnut Creek at Indiana Street. The data may or may not be used in determining a waste-load allocation for RFS in the future.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - No special measures are needed beyond standard operating procedures.

- Acceptable Decision Error Rates for Statistical Sampling Design:
  - If hydrologic changes affect pond chemistry, the historical distribution of analyte concentrations may no longer exist. The as-needed sampling for Walnut Creek should provide an adequate representation of the full range of concentrations likely to be in the waters flowing off Site. For Woman Creek, a sample will be collected every time the pond discharges.

Monitoring Targets:

As-needed (with a goal of semiannually) sampling will be done in Walnut Creek, and annual sampling will be done in Woman Creek—corresponding to the projected once a year discharge from Pond C-2.

2.5.3.2 RFS Non-POC Monitoring in Walnut Creek

Data Types and Frequencies:

- Nitrate, as sampled for at the Walnut Creek POCs GS03, GS08, and GS11 (see Figure 2−2), during terminal pond discharges only;
- Source of the water sampled. Monitoring at Indiana Street POC GS03 calls for samples to be segregated based on water origin (natural creek flows or terminal pond discharges commingled with natural flows);
- Samples collected will be continuous flow-paced composites; and
- Flow-paced monitoring is maintained at all times for the POCs.

Boundaries:

Spatial: Data collection is limited to non-POC monitoring locations GS03, GS08, and GS11.

Temporal: Data are collected continuously, during terminal pond discharges only, using automated equipment.

Monitoring Requirements:

Nitrate analysis will be performed for the same pond discharge samples collected under the POC monitoring objective (Section 2.5.2). Annual sample collection targets for the Walnut Creek POCs are given in Table 2−23.

Non-POC nitrate monitoring will be confined to samples taken during the terminal pond discharges at GS11, GS08, and GS03. Table 2−26 shows the associations between monitoring locations and station designators.

Table 2–26. Non-POC Monitoring Station Designators

POC	Monitoring Station Designators
Pond A-4	GS11
Pond B-5	GS08
Walnut Creek at Indiana Street	GS03

Decision Statement:

IF	The volume-weighted 12-month rolling average[13] for nitrate, as represented by samples from the specified terminal pond non-POC monitoring locations (GS08 and GS11), exceeds the appropriate RFCA standard—
THEN	RFS must notify EPA and CDPHE within 15 days of DOE-RFPO gaining knowledge that an exceedance (verified) has occurred to initiate the consultative process.
IF	The 85th percentile of the volume-weighted 30-day moving averages[14] of a given calendar year for nitrate, as represented by samples from non-POC monitoring location GS03 exceeds the appropriate RFCA standard—
THEN	RFS must notify EPA and CDPHE within 15 days of DOE-RFPO gaining knowledge that an exceedance (verified) has occurred to initiate the consultative process.

2.6 Off-Site Monitoring Objectives: Community Water Supply Management

Contaminants generated by operations at the Site may have migrated off Site and impacted the downstream reservoirs. The potential for the public to be exposed to contaminants originating from RFS that can impact the community water supplies engenders public concern. Government officials in the downstream communities must respond to this public concern with adequate and timely monitoring data.

The ultimate decision regarding the management of community water resources rests with the affected community; however, monitoring data generated by other entities, such as CDPHE and the Site, are used to assess potential impacts, demonstrate acceptable water quality, and allay consumer concerns. These data are critical inputs for operational decisions.

2.6.1 Monitoring Uncharacterized Discharges

This monitoring would normally be required only if monitoring specified under the previous decision rules is not performed in accordance with the sampling and analysis protocols (e.g., POE or POC monitoring at Indiana Street), or if flow leaving the Site exceeds the capacity of the downstream ditches or reservoirs.

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[13] The 12-month rolling average for the last day of a particular month is calculated as a volume-weighted average of a “window” of time containing the previous 12 months. Each 12-month “window” includes daily discharge volumes (measured at the location with a flow meter) and daily concentrations (from the sample carboy in place at the end of that day). Therefore, there are twelve 12-month rolling averages for a given calendar year. Days with no flow or no analytical result, either due to failed laboratory analysis or NSQ for analysis, are not included in the average. When no pond discharge has occurred in the last 12 months, no 12-month rolling average is reported.

[14] The 30-day average for a particular day is calculated as a volume-weighted average of a “window” of time containing the previous 30-days that had flow. Each day has its own discharge volume (measured at the location with a flow meter) and concentration (from the sample carboy in place at the end of that day). Therefore, there are 365 30-day moving averages for a location that flows all year. At locations that have intermittent flows, 30-day averages are reported as averages of the previous 30 days of greater than zero flow. For days where no activity is available, either due to failed laboratory analysis or NSQ for analysis, no 30-day average is reported.

If surface water of unknown quality (i.e., unmonitored water) leaves the Site, it is necessary to demonstrate that the water quality is acceptable to the downstream users. Examples include:

- Flow that has the potential to exceed the capacity of the Walnut Creek Diversion Ditch and enter Great Western Reservoir instead of being diverted around the reservoir; and
- Water quality in downstream waters that may have been impacted by unmonitored effluent from the Site.

Data Types and Frequencies:

- Flow at the following monitoring locations:
  - Pond A-4, North Walnut Creek, GS11,
  - Pond C-2, GS31,
  - Pond B-5, South Walnut Creek, GS08,
  - Woman Creek at Indiana Street, GS01, and
  - Walnut Creek at Indiana Street, GS03.
- Flow from these stations is needed to evaluate:
  - The potential for Walnut Creek to exceed the capacity of the Walnut Creek Diversion Ditch (estimated at 40 cubic feet per second [cfs]) and spill over into Great Western Reservoir, and
  - The relative contribution of various sources (ponds, storm drainages) to the total flow leaving the Site.

After the release event, water quality data may be evaluated in combination with flow data to estimate the total impact. Note that the flow data will already be available from monitoring performed under other decision rules, assuming flow channel capacities are not exceeded.

- Water quality as follows:
  - Analytes are shown in Table 2−27.

Table 2–27. Off-Normal Discharge Monitoring Inputs

Constituent Group	Short List	Long List
Radionuclides	Pu, Am, gross alpha/beta (rapid turnaround indicator)	Gross alpha/beta, Pu, Am, U (isotopic), tritium
Physical properties and general water quality measurements	pH, temperature, TSS, conductivity or TDS	pH, temperature, turbidity, TSS, conductivity, TDS, hardness, alkalinity, fluoride, chloride, sulfate
Nutrients	None	Nitrate, nitrite, ammonia (total and un-ionized), orthophosphate, total phosphorus
Organics	None	VOCs (EPA 524.2)
Metals	None	Metals having stream standards (As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Ni, Se, Ag, Zn)

Notes:
Ag = Silver; As = Arsenic; Am = Americium; Be = Beryllium
Cd = Cadmium; Cr = Chromium; Cu = Copper; Fe = Iron
Mn = Manganese; Ni = Nickel; Pb = Lead; Pu = Plutonium
Se = Selenium; TDS = Total dissolved solids
TSS = Total suspended solids; U = Uranium
VOC = Volatile organic compound; Zn = Zinc

Note: Constituents appearing on the "Short List" represent a minimum analyte list for all unplanned releases or discharges. Some or all of the constituents on the "Long List" may be necessary depending on the nature of the event, the source of the release, and the receiving water. The composition of either list may change depending on activities at RFS at the time of the event. Samples should be taken, but not necessarily analyzed, for all possibilities.

- Action levels:
  - Action levels would be the applicable CWQCC standard for the potentially impacted downstream segment.
- Sampling locations:

  Specific locations are event-driven, but may include:
  - Walnut Creek at Indiana Street, GS03,
  - Woman Creek at Indiana Street, GS01, or
  - Great Western Reservoir (only necessary if release of surface water enters Great Western Reservoir).
- Sampling frequency:
  - Event driven; only when uncharacterized water leaves the Site.
- Sample type:
  - Walnut and Woman Creeks at Indiana Street: If flow-paced composite sampling as specified under POC monitoring cannot be conducted, then grab samples will be collected as soon as the event is detected and at least daily thereafter until continuous monitoring is reestablished or the event terminates. If time-paced samples are available from Broomfield's monitoring station at GS03, these samples may be used to characterize water quality leaving the Site.
  - Reservoirs: Representative reservoir sampling will be conducted in accordance with the event and as agreed to by the impacted parties. At a minimum, a surface composite sample, consisting of grab samples collected at various points in the reservoir, and a depth composite sample, will be collected 48 hours after the event.

Geographically, this monitoring objective is bounded by the Walnut and Woman Creek basins, from the western Site boundary to the main stem of Big Dry Creek. However, the downstream communities are primarily concerned about the negative impact on downstream reservoirs and water supplies of contaminants leaving the Site; thus, the monitoring locations of interest are

- Woman Creek at Indiana Street, GS01;
- Walnut Creek at Indiana Street, GS03;
- Great Western Reservoir; and
- Woman Creek Reservoir.

For this decision, monitoring would only be required when water of unknown quality leaves the Site. Under routine operations, where surface water is under full management control of the Site, dam safety is not threatened, and POC monitoring is conducted as specified under Section 2.5.2, this monitoring is not needed.

Decision Statement:

IF	Surface water of unknown or unacceptable quality leaves the Site—
THEN	The affected community will take appropriate protective measures until analytical data show that water quality is acceptable for the intended use.

For example, in the event of a contaminant release to Woman Creek Reservoir, Westminster might refrain from discharging water downstream until water quality has been analyzed and determined to be acceptable.

Acceptable Decision Errors:

Because this monitoring is event-driven, decisions regarding necessary and sufficient monitoring must be based on the nature of the event. Samples may be single grab samples, location composites, or time composites. Statistically, based sample sizes will not be used for development of this monitoring plan.

Monitoring Targets:

For planning purposes, no uncharacterized discharges are projected. If such a discharge does occur and this monitoring is needed, then the number and type of samples would be determined on a case-by-case basis.

2.6.2 Community Assurance Monitoring

Citizen concerns are more effectively addressed by a routine monitoring program to measure the analytes of concern at the locations of concern than by institutional controls, modeling, and on-Site monitoring. Adequate and timely information regarding the Site's impact on the neighboring environment is needed so that the communities can respond to citizen concerns and the Site can foster a credible public image. Inadequate monitoring results lead to poor public relations, impaired trust, increased public resistance to proposed activities at the Site, and increased mandatory monitoring.

Data Types and Frequencies:

- Sampling locations:
  - Since the completion of the Standley Lake Protection Project and the Great Western Reservoir Replacement Project, which were designed to protect the potable water supplies, routine monitoring of the municipal treatment and distribution systems is no longer warranted. However, Great Western Reservoir is still used as an irrigation supply, and the fact that the reservoir is considered to be unsuitable for potable use raises questions on the part of irrigation customers. Ongoing assessment is needed to address these questions.
  - For the current plan, Great Western Reservoir is the only sampling location needed.

- Sample types:
  - Quarterly depth-integrated composite samples are adequate to characterize the contaminant concentrations in Great Western Reservoir.
- Sampling methods:
  - Broomfield personnel routinely conduct sampling in Great Western Reservoir and will collect the necessary samples for this objective as part of Broomfield's sampling program.
- Analytical methods:
  - Analytical methods must provide detection limits adequate to assess changes in water quality and to permit an acceptable comparison with steam standards. For Great Western Reservoir, the acceptable detection limit for Pu/Am is approximately 0.006 picocuries per liter (pCi/L).
- Analyte list:

  This monitoring is limited to radionuclide contamination that is potentially attributable to the Site.

  - Pu-239/240,
  - Am-241,
  - U, isotopic (at least U-233/234 and U-238), and
  - Tritium.

The total number of samples needed for this monitoring objective would be four samples per year. The hydrologic regime for the Great Western Reservoir will change over time as city irrigation and reuse projects are implemented. Sampling locations, types, and frequencies will be reevaluated to reflect these changes.

Decision Statement:

IF	The potential for public exposure to contaminants attributable to the Site causes reasonable concern in the neighboring communities—
THEN	Monitoring to quantify contaminant concentrations and provide the necessary information must be performed.

The response to a significant change in contaminant levels would be a different decision. The monitoring objectives described in previous sections are designed to prevent increased concentrations in the community drinking water systems. These community assurance monitoring data are used to address routine inquiries and to respond to occasions of unusual public concern. The data have been needed in the past and should be considered in future planning.

Acceptable Decision Errors:

Sufficient sampling and analysis must be performed to provide credible assurance that community water quality is adequately monitored and understood. A high level of confidence that the monitoring meets the desired objective is necessary. Because the type of monitoring involved is inconsistent with multiple samples, the required certainty must be achieved through appropriate sampling procedures, adequate sample volumes, laboratory quality control, and good analysis validation protocols.

Monitoring Targets:

Monitoring requirements for this section are presented in Table 2−28.

Table 2–28. Monitoring Targets (Number of Samples/Analyses) for Community Assurance Monitoring

Analyte	Analyses for FY 2005	
	Great Western Reservoir (Analyses per year)	Total
Pu-239/240	4	4
Am-241	4	4
Isotopic U[a]	4	4
Tritium	4	4

[a]Total U and U-233/234: U-238 ratio, at a minimum.
Notes:
Am = Americium
Pu = Plutonium
U = Uranium

2.7 Watershed Integration

Geographically, the Site lies at the head of the Big Dry Creek Basin; functionally, every effort has been made to isolate the Site from the rest of the watershed. Historical strategies on the part of both the Site and the downstream communities have focused on limiting, to the maximum extent possible, the natural flow of surface water from the Site. Examples include past spray irrigation practices, the “Zero Discharge” goal, and the detention of treated sanitary effluent and stormwater pending demonstration of acceptable water quality. Although these water management practices have been necessary to protect and reassure the downstream communities, they impact the ecology downstream and are inconsistent with the ultimate vision for the Site, as outlined in RFCA. Going forward, the focus must evolve toward integrating the headwaters of Big Dry Creek with the rest of the watershed.

To accomplish this objective, the Site must use the watershed approach, extend its water management strategy beyond Indiana Street, and participate with other stakeholders in identifying and implementing appropriate water quality and use goals for the basin. During 1996, DOE and its contractors progressed toward this goal by actively participating in a consensus group, with the objective of achieving agreement on as many issues as possible prior to a standard-setting hearing before the CWQCC. The group included representatives from the Site, regulatory agencies, and surrounding communities, but limited its focus to water quality issues impacting wastewater dischargers.

More recently, Site personnel helped to establish the Big Dry Creek Watershed Association (BDCWA), which began as an extension of the original consensus group, but evolved to include any entities or individuals interested in water-related issues within the basin. In addition to the original four dischargers, participants included representatives of agriculture, land owners, parks, recreation, open space, and a variety of government agencies. The BDCWA was recognized by the Denver Region Council of Governments (DRCOG) as a district watershed in the Regional Clean Water Plan. The goals of the association included public education, basin-wide planning, monitoring activities, and protection of water quality, aquatic life, and habitat.

DOE recognized the effectiveness of this approach by becoming a party to a formal agreement to participate, with the cities, in supporting monitoring activities within the basin. The agreement stated that such support may consist of monetary contributions or in-kind services, but shall be equitably distributed among the parties. Monitoring decisions were made jointly by the group, with input from regulators and planning agencies including EPA, the Water Quality Control District (WQCD), and DRCOG. The parties worked with the U.S. Fish and Wildlife Service (USFWS) and the BDCWA to determine an appropriate aquatic monitoring program. The immediate use of the data was to characterize the watershed and to identify and quantify sources of impairment. Ultimately, water quality and biological data were used to support water -quality standards, native species protection, and basin-wide planning activities. A coordinated effort to obtain accurate information about existing conditions and relative impacts was beneficial and cost-effective for stakeholders. In 2001, DOE contracted with a firm to conduct biological monitoring on Site. Information from Site monitoring activities was provided to the BDCWA for incorporation into their databases. The data were shared with the USFWS to assist with their management of Rock Creek Reserve.

End of current text

3.0 Ground Water Monitoring

3.1 Introduction

This section of the IMP describes newly updated (June 2006; see rationale for updates at the end of this section) ground water monitoring requirements for RFS as outlined in RFCA, and how these requirements will be implemented at RFS. Ground water monitoring is performed because ground water contaminant plumes occur within the RFS boundaries, and these plumes have the potential to impact surface water quality.

For detailed summaries of RFS and its environmental history (including areas of contamination), ground water contaminant plumes, physical and hydrological setting, and ground water monitoring history, refer to the FY 2004 IMP (FY 2004 IMP Background Document [Kaiser-Hill 2004a] and FY 2004 IMP Summary Document [Kaiser-Hill 2004b]).

The IMP for Ground Water serves as an omnibus plan to satisfy the requirements of several regulations and agreements. It satisfies the requirements of DOE Order 5400.1 (DOE 1988), replacing the *Groundwater Protection Management Program Plan* and *Groundwater Monitoring Plan*, which had previously been incorporated in a single document, and the *Groundwater Protection and Monitoring Program Plan* (GPMPP) (EG&G 1993). In addition, RCRA monitoring requirements for interim status units previously contained in the *Final Groundwater Assessment Plan* (GWAP) (DOE 1993) are incorporated. Finally, the document satisfies the requirements of RFCA, established in July 1996. The ALF portion of RFCA contains specific requirements for monitoring and reporting, and it sets action levels for contaminant concentrations in ground water and in other media (see Attachment 5 of RFCA). The IMP is required under RFCA to define the monitoring programs for RFS.

The Ground Water Monitoring Program is reevaluated at least annually to ensure that it is protective of the environment, compliant with applicable regulations and agreements, and aligned with the RFS closure mission. A DQO process is used to determine the function of each well in the network and the decisions supported by information from each well. DOE, CDPHE, EPA, and other stakeholder entities are directly involved in decisions concerning the monitoring network. Changes that have been made to the FY 2005 IMP, Rev. 1 (Kaiser-Hill 2005d) and are incorporated herein, include updates to the monitoring at the Present Landfill and Original Landfill to reflect the final monitoring requirements stipulated in the corresponding Monitoring and Maintenance Plans (DOE 2006a; 2006c).

3.2 Ground Water Interactions with Surface Water

There is considerable hydraulic connection between surface water and ground water at RFS. This connection is dominated by hillslope hydrology, occurring along stream channels, ponds, and ditches by way of natural hillside and channel seepage and artificial flow control structures, such as dams, that interrupt the natural flow of water. Streams nearest to the former IA are more likely to receive ground water impacted by past RFS activities and have traditionally been the focus of most ground water monitoring.

Three intermittent streams drain RFS: Rock Creek, Walnut Creek (consisting of three main tributaries—No Name Gulch, Walnut Creek, and South Walnut Creek), and Woman Creek.

Ground water is discharged from the Rocky Flats Alluvium and other surficial deposits through surface seeps and subsurface flow that, in turn, recharge stream flow and the stream valley ground water system. Segments of streams have been shown to either gain or lose water as ground water is discharged to streams, or stream water is discharged to ground water from the stream channel. Gaining reaches of streams are more likely to be contaminated by ground water discharges.

Ground water can also be transported to surface water directly through the RFS utility corridors, building sumps, foundation drains, and sanitary sewers. These systems have been removed or disrupted as a part of Site closure. However, the trenches in which they were installed can be filled with more permeable materials than the surrounding soils, thus creating a preferential pathway for ground water. Overall, water quality data pertaining to these corridors has indicated that contaminated ground water migrating along these pathways to surface water (i.e., not through pipes but rather through the backfilled trenches) is relatively minor.

3.3 Ground Water Monitoring Program Objectives

The objectives of the RFS Ground Water Monitoring Program are to 1) protect surface water quality; 2) demonstrate compliance with regulations; 3) support the design and selection of remedial measures; and 4) minimize the chances of further degradation of the upper hydrostratigraphic unit (UHSU).

Meeting these objectives requires that all monitoring wells be designed and constructed appropriately to provide the appropriate data for long-term monitoring. This was an area of focus in FY 2005, as approximately 30 wells were replaced. These replacements were necessary because the wells were either not well suited to long-term monitoring or had to be removed to make way for closure activities. When practicable, wells at high risk of damage were abandoned, and replaced afterward. Appendix B, which lists monitored locations, has been revised with updated well identifications and a crosswalk of original and replacement well identifications. (See Section 3.3.3.1 for additional discussion of well replacements.)

The Ground Water Monitoring Program was substantially revised for FY 2005; this IMP retains those changes, only updating the monitoring at the two landfills as noted above. The FY 2005 revisions reflect changes in the activities that were performed on the Site and changes that were anticipated at the end of FY 2005, as well as the need to develop a more focused monitoring network suitable for post-closure objectives. The revisions are supported by the current understanding of ground water contamination and contaminant sources resulting from many years of characterization. The monitoring program described in this 2006 IMP is expected to be very similar to the post-closure monitoring network at RFS that will be stipulated in an attachment to the LTS&MP issued after finalization of the Site CAD/ROD.

The 2006 ground water monitoring activities will

- Monitor contaminated ground water and sources of contamination;
- Monitor contaminant pathways to surface water;
- Develop resources for evaluating contaminant concentration trends using specific statistical methods;

- Monitor accelerated action activities;
- Monitor ground water flow for ground water modeling activities;
- Evaluate the effects of Site closure (particularly removal of buildings, underground utility infrastructure, and impervious surfaces such as pavement) on ground water characteristics; and
- Evaluate the impacts of ground water contaminants on surface water.

3.3.1 Identification and Monitoring of Contaminated Ground Water

The identification of contaminated ground water at RFS has resulted from previous investigations of former Operable Units (OUs), IHSS source areas, and facilities at RFS.

Ground water contaminant concentration maps have been generated for contaminants of interest at RFS and are published in the Annual RFCA Ground Water Monitoring Reports (e.g., the *2003 Annual RFCA Groundwater Monitoring Report*, Kaiser-Hill 2004c) and the Ground Water IM/IRA (Kaiser-Hill 2005b). Ground water plumes have been identified where contamination is spatially extensive and contiguous.

Contaminant sources are documented in the *Historical Release Report* (HRR), compiled to document spills and other releases of potentially hazardous chemicals at RFS (DOE 1992a). Prior to Site closure, the HRR was updated annually to document new sources of contamination. An IHSS number was assigned to any significant release.

Information about the IHSSs at RFS and the effect of contaminated areas on ground water is presented in Appendix D in pre-FY 2005 versions of the IMP, in the RFCA Annual Ground Water Monitoring Reports, and in the VOC Modeling Report (*Fate and Transport Modeling of Volatile Organic Compounds at the Rocky Flats Environmental Technology Site, Golden CO*; Kaiser-Hill 2004d). The remedial investigations at former OUs, combined with ground water characterization activities, have identified a number of ground water contaminant plumes that emanate from contaminant sources. These plumes are described in Appendix D of pre-FY 2005 versions of the IMP, and more recent investigations have been incorporated into the RFCA Annual Ground Water Monitoring Reports and the Ground Water IM/IRA (Kaiser-Hill 2005b). Generally, the principal category of hazardous contaminants in ground water is VOCs; in and downgradient of the Solar Ponds area, the principal contaminants are nitrate and uranium.

Accelerated actions have been performed to protect ground water by minimizing further migration of potential contaminants and/or by cleaning contaminated areas. The RFCA ALF requires performance monitoring of remedial actions. Analyte suites are developed for these wells based on knowledge of the analytes of concern at the remediation site, as suggested by the HRR (DOE 1992a) and further refined by years of ground water analyses in the various areas of the Site. Data are gathered to identify the nature and extent of contamination and the rate of contaminant migration, and if necessary, to develop a plan for appropriate remedial actions. Data generated by the Ground Water Monitoring Program support the goals of identifying and remediating existing contaminated areas, detecting new contamination caused by decommissioning and demolition or other activities, and preventing contamination of surface water.

In addition to the known IHSSs, ground water contaminant plumes, and contaminated building areas, there are other potential sources of ground water contamination. These include historical waste management areas, storage tanks, the process waste system, building drains and sumps, and areas where underbuilding contamination has occurred or where there are areas of soil contamination adjacent to buildings. The effect of these sources on ground water and surface water is investigated as part of the Ground Water Monitoring Program.

3.3.2 Identification of Potential Contaminant Pathways

To assess the direction and magnitude of contaminant movement, ground water migration pathways must be evaluated. The RFS ground water flow regime has been determined from many years of water-level measurements in monitoring wells. This information can be used to help estimate recharge and discharge rates, and it can be incorporated into potentiometric surface maps and ground water flow models that help predict the path along which contaminants may migrate. In addition, water-level data are necessary for determining contaminant flux to surface water, water balance, and ground water saturated thickness.

3.3.3 Identification of Elevated Contaminant Concentrations

Routine chemical analysis of ground water identifies the contaminants present and the concentrations of contaminants with respect to RFS action levels or standards. These data are compared against predetermined and well-specific concentrations to identify whether reported concentrations in ground water are indicative of worsening conditions.

Pre-FY 2005 versions of the IMP required comparison of analytical data against background concentrations (represented by the mean plus two standard deviations, or M2SD) and well-specific M2SD concentrations to determine whether the analytical data deviated from natural levels. This M2SD comparison strategy is no longer followed. Instead, depending on the well classification (see Section 3.3.9) and the analyte, concentrations are compared following one or more of the following criteria:

- Statistically derived 85th percentile concentrations to be compared with surface water standards (as discussed in Section 3.3.3.2);
- Specific statistical methods to determine concentration trends (Section 3.3.3.3);
- RFCA Tier I and Tier II Ground Water Action Levels;
- Concentrations in downgradient wells are compared against those in upgradient wells; and
- Comparison with Wildlife Refuge Worker Surface Water Preliminary Remediation Goals (WRW SWPRGs; Section 3.3.3.4; Kaiser-Hill 2004e).

In addition to these five criteria, a “threshold concentration” is used for comparison of U results (Section 3.3.3.5). (Data from wells associated with monitoring per the OU1 CAD/ROD or for RCRA purposes are evaluated differently, as discussed in their respective sections below.)

These concepts are discussed in depth below. Well classifications, which determine which of the criteria above apply, are discussed in Section 3.3.9.

3.3.3.1 Data Usage

Of the analytical data received from laboratories, 100 percent will be validated and verified. In addition, analytical results that appear anomalous or are of special interest may receive more detailed validation on request. The Ground Water Lead shall make the final determination of whether validation is warranted. Data that are qualified as “rejected” during the validation process (validation qualifier containing an “R”) shall not be used in any of the data evaluations.

Interpretation of analytical data for any analyte in which the result is qualified with a “U” (not detected at the reported detection limit) may be considered nondetects.

Ground water data evaluations shall be based on water sampling performed since January 1, 2000. This cutoff date allows sufficient historical data for evaluation of recent ground water quality trends without the bias introduced by including much older data collected when the Site was far from closure. Exceptions to this date may be made if necessary and if supported by professional judgment. In particular, all U data generated using high-resolution inductively-coupled plasma/mass spectrometry or thermal ionization mass spectrometry analytical methods (abbreviated as HR ICP/MS and TIMS, respectively) have been included, regardless of the date of analysis. These data were collected from selected locations for characterization purposes beginning in 1999.

Analytical data for primary (“real”) samples will be used for evaluating ground water quality trends and 85th percentile calculations. Samples collected to meet QA/QC requirements (e.g., field duplicates and equipment rinsates) may be used in performing data quality assessments (DQAs).

Numerous wells were replaced (Appendix B, Table B−4) as a result of Site closure activities. The appropriateness of pooling data from the “original” well with those from the “replacement” well (or wells, if the well has been replaced more than once) will be determined on a case-by-case basis using professional judgment.

The following three examples illustrate why inflexible data-pooling requirements would be inappropriate.

1) Some wells have been replaced because the original well was inadvertently damaged or had to be removed to make way for demolition activities. Construction, design, and location of the replacement well may be essentially identical to that of the original well. In cases such as this, data from the original and replacement wells should probably be pooled.

2) In some cases, “original” wells were installed within a contaminant source area that was subsequently remediated via source removal, thereby also removing the original well. A replacement well may then have been installed at the downgradient edge of the excavation boundary after source removal activities were completed. Pooling of data from the original and replacement wells in this case would typically not be appropriate.

3) If the geochemical conditions displayed by the analytical data from the replacement well are markedly inconsistent with those from the original well (as may be evident in trend plots, for example), it may be appropriate to discontinue data pooling. Discontinuous trend plot behavior would be evident in the second example above, but in some instances the reason for the inconsistencies may not be known (e.g., there was no source removal).

3.3.3.2 Comparing Data with Standards

RFCA requires that analyte concentrations in ground water be compared against the greater of the action level (AL), practical quantitation limit (PQL), or temporary modification (MOD). Because Site ground water quality must be protective of surface water quality, the ground water quality data will be compared with surface water ALs, PQLs, and MODs as described below. The surface water ALs, PQLs, and MODs are hereafter referred to collectively as "surface water standards." Analyte concentrations in ground water may also be compared against concentrations reported at other wells or WRW SWPRGs (Appendix B, Table B−5; Kaiser-Hill 2004e), defined earlier.

Concentrations of a particular analyte in a particular monitoring well are referred to as an "analyte well" combination. Concentrations of an analyte well will not be considered to be greater than the applicable surface water standard until the 85th percentile of the data for that analyte well are above the standard. This will prevent a single data point with its associated uncertainty in sampling and analysis from causing unnecessary follow-up actions.

The 85th percentile of the analyte well data is estimated by the nonparametric method described by CWQCC (2004, p. 4). This procedure is as follows:

- Nondetect concentrations shall be replaced by zeros for the procedure.
- Potential data outliers are retained in the working data set.
- The concentration data are grouped by analyte and then by well.
- Within each group of "n" data points, the concentrations are sorted in ascending order from smallest to largest concentration.
- Each concentration is assigned an integer rank or "order statistic." The first nondetect (or smallest detect if there are no nondetects) is assigned rank 1. The largest concentration is assigned rank n.
- The 85th percentile is estimated by the concentration whose rank is 0.85(n+1), if the rank is an integer.
- If the above percentile rank is not an integer, the rank is rounded to the closest integer rank. The 85th percentile is then taken as the concentration of the closest integer rank.
- In cases where the direction of rounding is ambiguous, interpolation between the ranks is suggested. This issue is not addressed by CWQCC (2004).
- Percentiles shall not be estimated until there are a minimum of eight concentration measurements (i.e., eight successful sampling events) for an analyte well. This is consistent with the minimum data set for trending, discussed in Section 3.3.3.3. CWQCC does not address the minimum sample size for estimating percentiles.

The procedure of CWQCC (2004) is nearly identical to that given by the widely cited statistical text, Snedecor and Cochran (1967, p. 125) for estimating percentiles of any continuous frequency distribution. The difference is that Snedecor and Cochran (1967) call for linear interpolation of the percentile when the order statistic is not a whole number. CWQCC (2004) calls for "rounding down," which we interpret as ordinary rounding to the nearest integer, rather than truncation to the next lower integer.

3.3.3.3 Trend Analysis

Ground water quality data will be compiled into a database and shall be evaluated for trend as follows:

- Trends shall not be estimated until there are a minimum of eight regularly scheduled concentration measurements (i.e., eight successful sampling events from the routine semiannual or other applicable schedule) for an analyte well.
- Trend analysis requires a minimum of four data points per sampled season.
- Potential data outliers are retained in the working data set.
- It is not necessary to test for trend if all of the concentrations for an analyte well are nondetect. There is no evidence of trend in this case.
- Nondetect concentrations will be replaced by zeros so that nondetects are lower than detects at the reporting limit. This also treats all nondetects as ties when multiple reporting limits are present in the data.
- Data for each analyte well shall be tested for trend by applying the nonparametric, Seasonal-Kendall (S-K) test and the associated S-K slope estimator (Kaiser-Hill 2004f). The S-K test is described by Hirsch et al. (1982) and by Gilbert (1987, Chapter 17). If the well is sampled on an annual or biennial schedule (once per year or once every other year, respectively), the Mann-Kendall (M-K) test may be used if desired, since seasonality will not be a factor.
- The S-K (or M-K, if applicable) test shall be applied at the 95 percent level of confidence for a one-tailed test (i.e., false positive error level $\alpha = 0.05$).
- It is recommended that the S-K (or M-K) method be calculated by commercially available statistical software (e.g., WQstat Plus [IDT 1998]). A Fortran program is also available for this task by Gilbert (1987, Appendix B). (Brand names are mentioned for information only. This IMP does not endorse any particular software.)

The null hypothesis (H_0) of the S-K test is that there is no trend. The S-K test statistic is called "Z." The one-tailed S-K test for an uptrend at the $\alpha = 0.05$ level finds sufficient evidence to reject H_0 if test statistic Z is positive and greater than table value $Z_{0.95}$. Table values for the test may be found in Gilbert (1987, Table A1). Similarly, statistically significant evidence of a downtrend is found when Z is negative and the absolute value of Z is greater than $Z_{1-\alpha}$. Further considerations on trend testing of RFS ground water data are found in Kaiser-Hill (2004f).

3.3.3.4 Comparison with WRW SWPRGs

To determine whether concentrations are indicative of sharply worsening conditions and therefore warrant urgent response, reported results are compared against calculated WRW SWPRGs (Appendix B, Table B−5). These values are from Table A-6 of the *Final Comprehensive Risk Assessment Work Plan and Methodology – Appendix A – Human Health Screening-Level Preliminary Remediation Goals* (Kaiser-Hill 2004e). To ensure that spurious data do not cause unnecessary action, a confirmation water sample shall be collected and analyzed during the next regularly scheduled sampling event. If historical data for the analyte well have exceeded the WRW SWPRG prior to implementation of this IMP, then no action shall be taken if future samples continue to exceed the WRW SWPRG. In such cases, trend analysis will indicate worsening conditions if an uptrend is identified.

3.3.3.5 Comparison with "Threshold" Concentration of Uranium

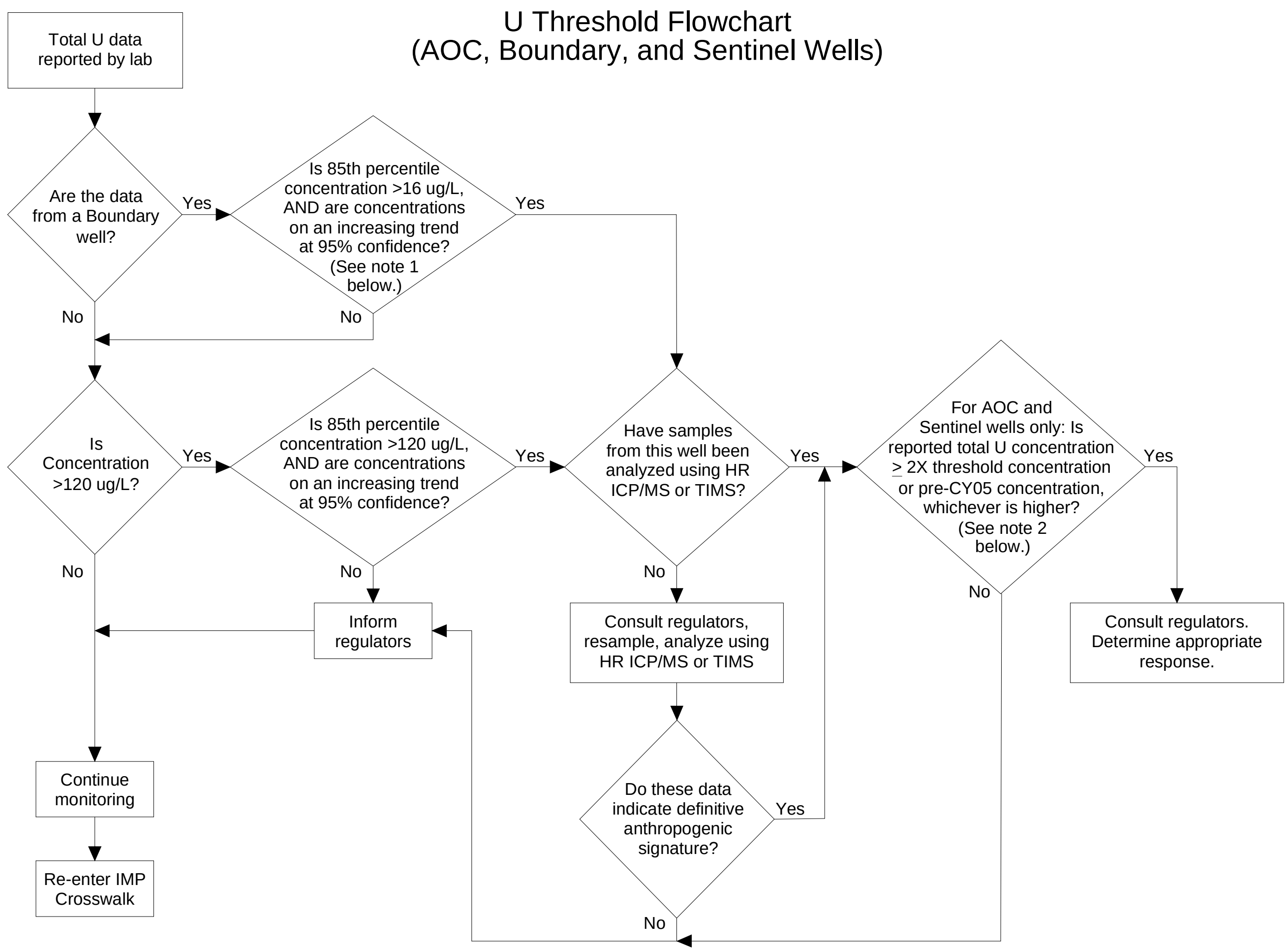
RFS is located in an area with high background levels of U in ground water. These background levels are naturally occurring. Therefore, because the corresponding U surface water standard is relatively low, a separate rule has been designed for U concentration comparisons.

In contrast to pre-FY 2005 versions of the IMP, in which the analytical suite required ground water samples to be analyzed for U isotopes, the samples collected in 2006 will be analyzed for mass-concentration of U (also referred to as "total U"). The 85th percentile of total U concentrations at a given AOC, Sentinel, or Boundary well, will be calculated along with the statistical trend of the data. These results will be evaluated as shown in Figure 3−1.

Concentrations of total U from a given AOC, Sentinel, or Boundary well, will be assessed using statistical trending, calculation of 85th percentile, and comparison of the 85th percentile concentration with a specific "threshold concentration." The threshold concentration of total U for AOC and Sentinel wells is 120 micrograms per liter (μg/L), and for Boundary wells is 16 μg/L.

The threshold values were selected in negotiations with CDPHE and EPA. The 16 μg/L concentration is based on a conversion of the surface water standard. The 120 μg/L concentration is rounded from the grand mean of samples collected at RFS and analyzed using HR ICP/MS or TIMS through ground water characterization efforts of 1999-2003. As a part of these efforts, over 50 wells at RFS were sampled for the analysis of U using HR ICP/MS or TIMS. Results of HR ICP/MS and/or TIMS analysis can be assessed to determine whether the isotopic signature is indicative of natural U (i.e., naturally present in the soils and rocks at RFS) or shows anthropogenic (man-made) influence. Due to the elevated natural U concentrations at RFS, this determination is important in designing a response to elevated U concentrations.

If the 85th percentile total U concentration of a given well exceeds the threshold concentration for the corresponding well class, additional inspection of the data will be required. The statistical trend of the U data (see Section 3.3.3.3) will be calculated to determine whether it is increasing at the 95 percent confidence level. If it is, the next consideration will be whether samples from the well have previously been analyzed using HR ICP/MS or TIMS; if not, this will be one component of the follow-up. If samples from an AOC or Sentinel well have been analyzed using either of these methods, the just-reported total U result will be compared against two times the highest pre-calendar year 2005 concentration and two times the associated U threshold. Concentrations exceeding these values will signal off-normal conditions that warrant careful inspection.



NOTE: 1) For Boundary wells, the 16 ug/L figure is based on the 11 pCi/L surface water standard converted to mass units, assuming a natural isotopic signature: 11 pCi/L ÷ 0.68527 ug/pCi = 16.052 ug/L, rounded to 16 ug/L for convenience.
2) "Threshold" concentration is 120 ug/L for AOC and Sentinel wells.
"Highest pre-CY05" concentration is maximum of either reported total U (i.e., concentration in mass units) or as calculated from isotopic data (converted from activity units to mass units). See Table B-6 for a lookup table.

Figure 3–1. Uranium Threshold Flowchart

The highest pre-calendar year 2005 concentration will be represented either by data reported as total U (i.e., in units of mass), or by data reported as isotopic activities that are then converted to mass and summed for an equivalent total U concentration. Data to be used for this comparison include isotopic and total U data from samples collected between January 1, 2000, through December 31, 2004, and all HR ICP/MS and TIMS data. For wells in the monitoring network represented by pre-2005 data, a lookup table containing corresponding well-specific maximum total U concentrations for this timeframe is included in Appendix B.

The isotopic data resulting from HR ICP/MS or TIMS analysis shall be reviewed to determine if they indicate a natural or anthropogenic signature. Next, one of two options will be taken:

- If a natural signature is indicated, normal sampling and analysis shall resume.
- If a definitive anthropogenic signature is indicated, the action specified for that well classification in Section 3.3.9 shall be performed. Any action that may be required following confirmation of a definitive anthropogenic signature for a well may call for assessments, evaluations, or analyses to be performed; those well-specific requirements, and any actions that are initiated through that process, shall supersede this generalized IMP U requirement for as long as those well-specific requirements are in effect.

Decisions that may be required in response to detection of elevated concentrations of total U will be made following the decision flowchart shown in Figure 3−1.

3.3.4 Monitoring of Accelerated Actions

RFCA requires that ground water performance monitoring be conducted during and after certain soil accelerated actions. Pre-FY 2005 versions of the IMP denoted which wells were dedicated to this purpose through the “Performance Monitoring” well classification. The FY 2005 IMP revised these classifications and took a more streamlined and Site-wide approach, with data from each well typically satisfying more than one DQO. As a result, performance monitoring objectives are incorporated into the Sentinel and/or Evaluation well classes, as appropriate.

Accelerated actions that are currently monitored include soil removal actions at IHSS 118.1 (completed in late calendar year 2004), Trenches T3/T4, Ryan’s Pit, the Mound Site, and Oil Burn Pit #2 (completed in FY 2005); ground water enhancements at the PU&D Yard, 903 Pad, and Ryan’s Pit (both of the latter two completed in late FY 2005); and the ground water plume treatment systems that have been installed downgradient of the Mound, East Trenches (OU2), and the former Solar Ponds (OU4). Monitoring of these three treatment systems is performed in accordance with the respective decision documents (*Decision Document for the Mound Site Plume*, DOE, 1997; *Proposed Action Memorandum for the East Trenches Plume*, DOE 1999a; and *Final Solar Ponds Plume Decision Document*, DOE 1999b). Performance monitoring of the now-decommissioned 881 Hillside French drain and collection system is no longer required, but the ground water plume is still monitored in accordance with the OU1 CAD/ROD (DOE 2001a). (See previous versions of the IMP for additional information on the ground water plume treatment systems.)

If additional accelerated actions are performed, performance monitoring decisions and specific monitoring requirements related to these projects will be identified in decision documents. Those monitoring elements will be incorporated via updates to the IMP.

3.3.5 Evaluation of Ground Water Contaminant Impacts on Surface Water

The primary objective of the Ground Water Monitoring Program is to protect against impacts to surface water quality. In the event that monitoring data show that a ground water contaminant plume is approaching surface water and may adversely impact surface water quality, a ground water evaluation will be performed to assess this impact. In areas in which an impact to surface water has been previously recognized and evaluated (for example, downgradient of the ETPTS intercept trench near Ponds B-2 and B-3, and along North Walnut Creek between the SPPTS and Pond A-1), a significant increasing trend adjacent to surface water will require the performance of another evaluation.

It is not feasible to include in this IMP the specific activities and data that might be required to assess potential impacts to surface water. An activity plan will be prepared each time an evaluation is required to identify the specific DQOs necessary for the proper collection and interpretation of information, such that a thorough, data-based impact assessment can be made. Activities that may be included are a review of historical data from the well and others nearby, review of the HRR, field walkdowns to search for visible physical changes, contaminant fate and transport modeling, special sampling, and other data collection activities. Refer to Section 3.5.5 for additional discussion on ground water evaluations.

3.3.6 Exit Strategy for Ground Water

Ground water monitoring at the Site will not be required "forever" because contaminant concentrations are expected to slowly decrease through natural attenuation mechanisms. Therefore, rules must be established to logically guide termination of ground water monitoring, even though it is unlikely that such a process will be implemented during 2006. The logical process by which ground water monitoring is terminated is referred to as the exit strategy. This topic has not been included in previous versions of the IMP, but must be considered during and after Site closure.

Concentrations, below which monitoring for the various ground water contaminants is no longer needed, will vary to some extent based on analyte and well classification. For example, wells at a ground water discharge area will be held to stricter requirements than wells within a mesa-top contaminant source area because of the importance of protecting surface water quality at the discharge area. Similarly, exit criteria for ground water treatment systems vary from those for monitoring wells. The criteria for comparison are summarized in Section 3.3.3, and their application to the different well classifications is presented in Section 3.3.9.

Ceasing to monitor ground water may take place area-by-area at RFS rather than for the Site as a whole, and may also occur by analyte suite (for example, stop monitoring a given well for U but continue to monitor for VOCs). As concentrations of contaminants in ground water in a given area decrease to the point that they meet exit criteria, there will no longer be a need to monitor that area. Exit criteria include factors such as the concentration trend and surface water standards or WRW SWPRGs. In all cases, the RFCA consultative process will be employed to make sure that the appropriate parties (including DOE, USFWS, CDPHE, and EPA) are considered in the decision to stop monitoring. See Section 3.3.9 for additional discussion of specific exit criteria for the different well classes.

3.3.7 Ground Water Data Quality Objectives

DQOs are qualitative and quantitative statements that specify the type, quality, and quantity of the data required to support the decision-making process. DQOs are established to make sure that a project has been logically defined and planned, and that the project scope and data that are collected will support the eventual decisions required. QC objectives are established to make sure that data generated by a project will be gathered or developed using procedures appropriate for the intended use of the data. The DQO process is generally derived from EPA guidance documents (e.g., EPA 1987, 1990, and 1994) but has been used primarily as a decision support tool as opposed to a sample optimization tool.

General DQOs for the different well classes are provided in Section 3.3.9. Well-specific DQO summaries are presented in Appendix B.

3.3.8 Programmatic Data Quality Objectives

The DQO process has been applied to the Ground Water Monitoring Program at a programmatic and decision-specific level. At the programmatic level, the DQO process has been used to qualitatively specify the overall need for, and purpose of, ground water monitoring. This effort established that ground water data are needed to comply with applicable regulations, agreements, and permits, and to prevent unacceptable impacts to surface water quality. The data will result from regular sampling of wells and surface locations selected to meet the above criteria. These data are used to detect and document contaminant concentrations above limits established by regulations, agreements, permits, or risk-based analysis; to support modeling and evaluations; and for periodic monitoring reports to regulators. Sampling locations, frequency, and analytical suites have been negotiated with regulators. Locations have been chosen to detect migration of known contaminant plumes along pathways and across boundaries. Analytical results need to be of specified, documented quality, owing to the many uses of the data for modeling, risk assessment, performance assessment, and compliance. Section 3.5 provides detailed discussion of the programmatic DQOs for ground water monitoring.

3.3.9 Data Quality Objectives for Program Elements

The second DQO effort developed individual monitoring program decision elements. DQOs were approached on a media-specific basis, although the goal was to integrate monitoring requirements for ground water, surface water, air, and ecology where appropriate. Ground water monitoring DQOs were developed for each component of the program, and problem statements were established. These problem statements were then refined into a decision statement that specified actions for that problem. The data were then identified and methods of analysis outlined to support the decision. Boundaries and scope are defined to clarify the spatial and temporal focus of the required monitoring information and exclude nonessential aspects of the problem. A decision rule is specified to document how data will be summarized to draw a conclusion upon which a decision will be based.

The FY 2005 IMP eliminated the former nine well classifications and established a simpler system. The changes reflect the evolving purpose of ground water monitoring at the Site; rather than characterizing ground water contamination, the monitoring network will be fulfilling long-term post-closure data needs. The network was therefore designed from a more holistic perspective. Rather than monitoring ground water around specific IHSSs and buildings, for example, the network targets important contaminant plumes, pathways to surface water, and drainages. This logical foundation led to the design of new well classifications with new decision rules and DQOs.

The ground water monitoring network is now defined with the following components:

- AOC Wells: Wells that are within a drainage and downgradient of a contaminant plume or group of contaminant plumes. These wells will be monitored to determine whether the plume(s) may be discharging to surface water. These wells will also be monitored for water levels. Considered with AOC wells are Surface Water Support locations, which are similarly located and follow the same decision rules; they support ground water objectives. Surface water locations are also discussed in Section 2.0.
- Sentinel Wells: Wells that are typically located near downgradient contaminant plume edges, in drainages, and at and downgradient of ground water treatment systems. These wells will be monitored to determine whether concentrations of contaminants are increasing, and for water levels.
- Evaluation Wells: Wells that are typically located within ground water plumes and near plume source areas, or in the interior of the former IA. Data from these wells will help determine when monitoring of an area or plume can cease. A subset of these wells is located in areas that may experience significant changes in ground water conditions as a result of Site closure activities. Data from these wells will assist in evaluating predictions made through ground water modeling. Evaluation wells will also be monitored for water levels.
- Boundary Wells: Wells located on the east boundary of the Site, where Walnut Creek and Woman Creek flow off Site. These wells will be used to show that the ground water leaving the Site in these two main drainages is not adversely impacted by upgradient conditions. Also monitored for water levels.
- RCRA Wells: Wells dedicated to monitoring the Present Landfill and Original Landfill to determine the effects on ground water resulting from these closed facilities. RCRA wells will also be monitored for water levels.
- Decision Document Wells: Wells identified in any of four decision documents and that the Ground Water IMP Working Group recommended be either removed from the monitoring network (in most cases) or be reclassified for reduced monitoring (in a few cases, described below) when these documents are modified or replaced. (These recommendations were devised during the development of the FY 2005 IMP.) Where it would not lead to confusion, those identified in a decision document and recommended for retention in the network are addressed under other well classifications (e.g., Sentinel, Evaluation).
    1) *OU1 CAD/ROD*: Wells located on the 881 Hillside and identified in the corresponding CAD/ROD (DOE 2001a) to monitor the OU1 Plume and the corresponding ground water pathway to surface water. Six wells are identified in this document. The Ground Water IMP Working Group recommended that this network be replaced with one of the six pre-existing wells and one new well. Until the CAD/ROD is formally modified or replaced, the 2001 version will be followed. The six wells are considered Decision Document wells for the purposes of this 2006 IMP. The new well is assigned AOC classification. The Ground Water IMP Working Group recommended the pre-existing

well that should be retained (891WEL, which replaced 891COLWEL) be reclassified as an Evaluation well after the CAD/ROD is modified or replaced.

2) *Mound Site Plume Treatment System*: Wells and piezometers located within, adjacent to, and downgradient of the ground water intercept trench to monitor the effectiveness of the trench in collecting contaminated ground water and diverting it to the treatment cells. The *Decision Document for the Mound Site Plume* (DOE 1997) identifies one downgradient well (3586) for analytical monitoring, and also refers generally to piezometers (there are five) and wells (there are seven) to be used for water-level measurements. The Ground Water IMP Working Group recommended that a different downgradient well be monitored for water quality (15699, one of the seven monitored under the decision document for water levels), and that water-level measurements be reduced to those from this well. Until the Mound Site Plume decision document is formally modified or replaced, the 1997 version will be followed. For the purposes of this IMP, well 15699 is classified as a Sentinel well, well 3586 is classified as a Decision Document well, and the other 11 locations are classified as Water Level wells.

3) *East Trenches Plume Treatment System*: Wells and piezometers located within, adjacent to, and downgradient of the ground water intercept trench to monitor the effectiveness of the trench in collecting contaminated ground water and diverting it to the treatment cells. The *Proposed Action Memorandum for the East Trenches Plume* (DOE 1999a) identifies one downgradient well (23296) and generally refers to another group of downgradient wells for analytical monitoring, and also generally refers to a group of piezometers installed within the trench for water-level measurements. Three existing locations are monitored for water quality, and three are monitored for water levels. The Ground Water IMP Working Group recommended that the wells monitored for water quality be retained for this purpose, and that water-level measurements be reduced to those from these wells. The Working Group also recommended that an additional well, located downgradient of the trench be similarly monitored. Until the Proposed Action Memorandum (PAM) is formally modified or replaced, the 1999 version will be followed. For the purposes of this IMP, the wells monitored for water quality are classified as Sentinel wells (as is the additional well recommended by the Working Group), and those monitored for water levels are classified as Water Level wells.

4) *Solar Ponds Plume Treatment System*: Wells and piezometers located within, adjacent to, and downgradient of the ground water intercept trench to monitor the effectiveness of the trench in collecting contaminated ground water and diverting it to the treatment cells. The *Final Solar Ponds Plume Decision Document* (DOE 1999b) identifies two monitoring wells downgradient (1386, 1786) and an additional well cluster north of the western end of the trench (70099, 70299) to be monitored for water quality, and piezometers within the trench to be monitored for water levels. (Well 1386 has since been replaced by well 51605.) As a result, four wells are monitored for water quality, and four piezometers are monitored for water levels. The Ground Water IMP Working Group recommended that a group of three wells (51605, 70299, B210489) be monitored for water quality, and that water-level measurements be reduced to those from these wells. Until the Solar Ponds Plume decision document is formally modified or replaced, the 1999 version will be followed. For the purposes of this IMP, wells 51605 and 70299 are classified as Sentinel wells, well B210489 is classified as

an Evaluation well, wells 70099 and 1786 are classified as Decision Document wells, and the trench piezometers are classified as Water Level wells. When the Solar Ponds Plume decision document is modified or replaced, the classification of well 51605 should be restored to Evaluation, per the recommendations of the Ground Water IMP Working Group.

The following monitoring classifications are addressed in this IMP in subsequent sections:

- Ground Water Treatment System Monitoring Points: Three ground water treatment systems collect and treat contaminated ground water and discharge the treated water to surface water. Each system is monitored, at a minimum, for influent and effluent water quality, and for impacts to surface water downstream of the effluent discharge point.
- Water Level Wells: Monitoring wells located between areas being actively monitored and in areas subject to changing flow conditions during and following Site closure. Data from these wells will be particularly important where closure-related changes to the land configuration and/or infrastructure (e.g., water supply system) are expected to cause changes to the water table. These wells are also available to support ground water evaluations if needed. A subset of these wells focuses on the ground water treatment systems; routine data collection from these should be eliminated when the associated decision documents are revised to reflect the recommendations of the Ground Water IMP Working Group.

RFS ground water has a surface water protection use classification and must be managed to be protective of surface water quality. The ALF lists specific analytes and associated ground water action levels. DQO decisions reflect the RFCA requirement to support the surface water protection classification.

Figure 3−2 presents the crosswalk for the different well classifications described above, and serves as a starting point for the classification-specific discussions that follow.

3.3.9.1 Area of Concern Wells

AOC wells are situated to enable the recognition of ground water impacts to surface water. Such an impact will be based on an analytical record that consistently indicates an impact, not on a single data point. Actions will comprise ground water evaluations, the components of which will depend on the DQOs constructed for the specific impact being evaluated. Ground water evaluation components may include (but are not limited to) such activities as

- Review of the data from the AOC well and other wells upgradient (Sentinel and Evaluation);
- Review of data from abandoned wells in the area;
- Review of surface water data;
- Review of the HRR for possible source areas contributing to the impact;
- Field walkdowns to inspect local and upgradient conditions;
- Communication with projects that may be or may have worked in a potential source area and altered or evaluated conditions; and
- Specially designed field investigations and sampling.

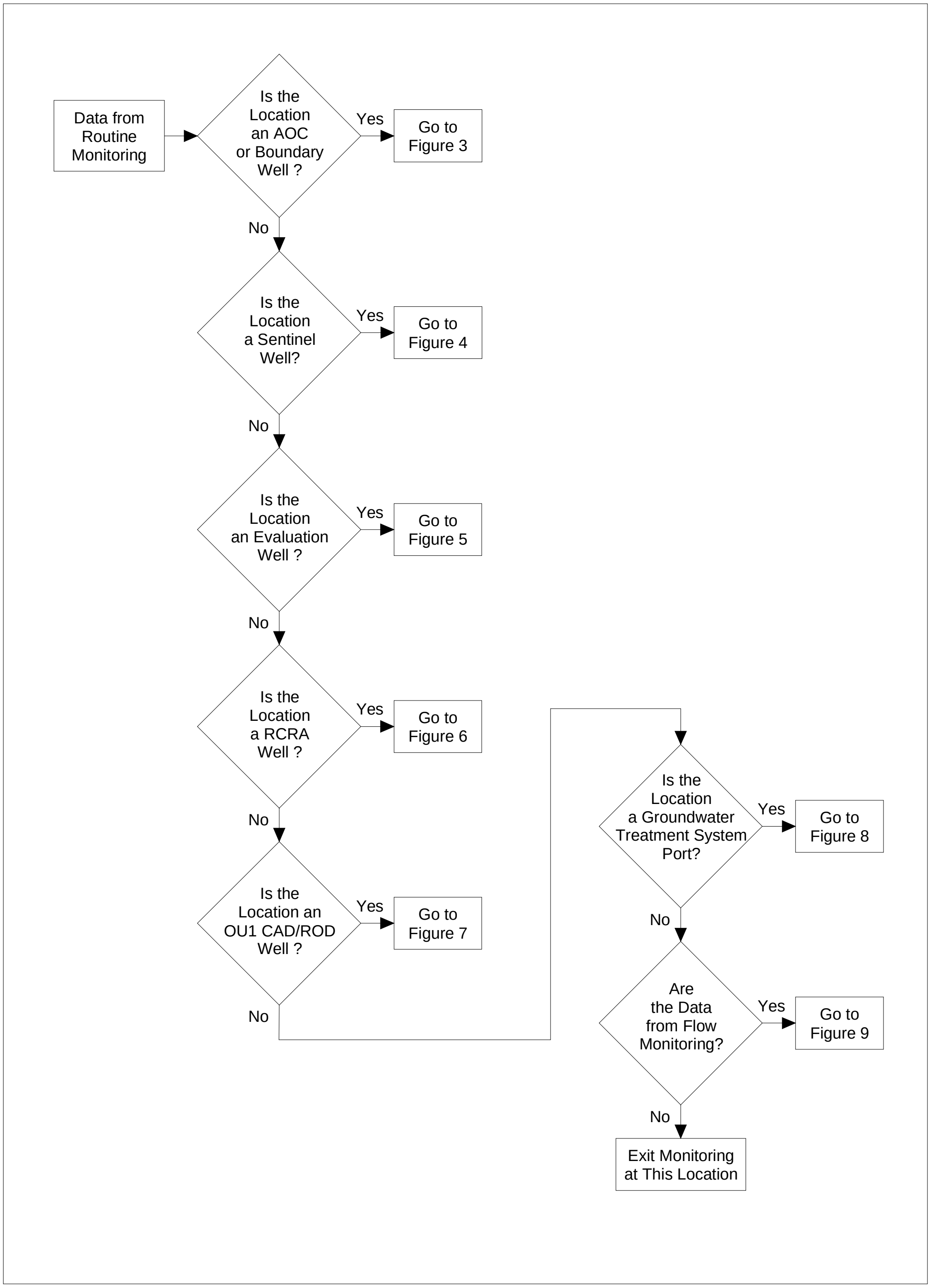


Figure 3–2. Ground Water Monitoring IMP Crosswalk

Failure criteria that must be met to require a ground water evaluation are specific to AOC wells (Figure 3−3), and require comparison of analytical results against the surface water standard(s), the historical trend for the AoIs at the given AOC well, and the WRW SWPRG concentrations for the AoIs. This is explained in greater detail below. See also Section 3.5.5 for additional discussion of evaluations of surface water impacts.

Surface Water Support locations, at which grab samples of surface water are collected to support ground water objectives, are included in this section because they follow the same decision rules as AOC wells.

Problem Statement:

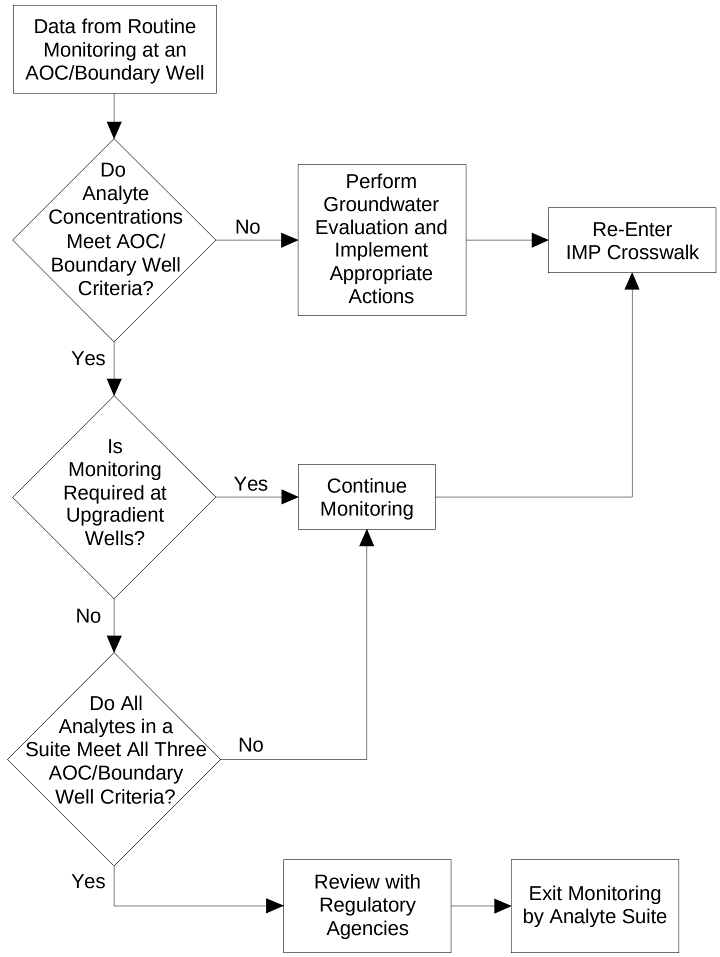
Are contaminants detectable, increasing or decreasing in concentration with time, or showing the potential to impact surface water?

Problem Scope:

AOC wells are located in drainages either downstream of or adjacent to where ground water contaminant plumes would discharge to surface water. These wells are used to monitor the performance of an accelerated action (including soil/source removals, ground water treatment systems, and facility demolitions) and to assess contaminant trends at important locations. Data from AOC wells are supplemented by those from Sentinel and Evaluation wells, and are used to determine when monitoring can cease or whether additional remedial work should be considered.

Data Types and Frequencies:

- Surface water ALs;
- Uranium threshold (see Figure 3−1);
- WRW SWPRGs;
- Selected analyte suites including the AoIs, based on historical data (see Appendix B);
- Well-specific historical data for AoIs;
- Statistically derived, well-specific historical data trends for AoIs;
- Field parameters;
- Water levels; and
- Ground water quality data for upgradient wells.



- AOC wells are sampled twice every year.
- Boundary wells are sampled once every year.
- See Figure 3-1 for decisions related to uranium.

<u>AOC Well Criteria</u> (Analyte-specific; <u>BOTH</u> #1 <u>AND</u> either #2 or #3 must be met.)
1. Analyte concentrations in the two most recent samples *do not exceed* WRW SWPRGs.
2. The 85th percentile concentration of an analyte *is less than or equal to* the corresponding surface water standard.
3. Analyte concentrations exhibit an indeterminate or statistically significant *decreasing* trend at the 95% confidence level.

Figure 3–3. Area of Concern and Boundary Wells

Boundaries:

Spatial: AOC wells are located in drainages at or below where contaminated ground water may discharge to surface water. Decisions will be made on the basis of the upgradient plume(s) monitored by each AOC well. If ground water monitoring is required upgradient of an AOC well, that AOC well must continue to be monitored.

Temporal: AOC wells will be sampled semiannually, during the second and fourth calendar quarters. Data will be reviewed and reported semiannually. If reported results are such that a ground water evaluation is required, the evaluation will be initiated within three months of receipt of the results driving the evaluation. Other decisions will be made annually. The well network will be reviewed (and revised, if necessary) a minimum of once every 5 years. Review of data to determine whether monitoring may cease will be performed as analytical results approach exit requirements; once monitoring has ceased, corresponding data reviews, data reporting, and monitoring decisions will no longer be performed.

Decision Statement:

IF Measured concentrations of an AoI other than U (see Figure 3−1) in the current suite exhibit a statistically significant increasing trend at 95 percent confidence (Criterion 1), AND the 85th percentile of the data is greater than the larger of the corresponding surface water standard or PQL (Criterion 2), OR
Most recently measured concentration of an AoI exceeds the WRW SWPRG (Criterion 3) AND concentrations above WRW SWPRG in the prior sample are confirmed by the current sample—
THEN If there has been no prior ground water evaluation addressing these observations, or these observations indicate the prior evaluation was not adequate, perform a ground water evaluation and implement findings—
ELSE Determine whether monitoring may be terminated.

IF Monitoring is required at any upgradient wells (of any class)—
THEN Continue monitoring the AOC well—
ELSE Perform data record comparisons, using Criteria 1, 2, and 3 above.

IF Upgradient wells are no longer monitored and measured concentrations in the AOC well do not meet any of Criteria 1, 2, or 3—
THEN Review conditions with regulatory agencies and exit monitoring by analyte suite, as appropriate following results of the preceding comparisons—
ELSE Continue monitoring.

Figure 3−3 presents the above decision tree for AOC wells in flowchart format.

AOC Surface Water Support Locations

Two locations in surface water are monitored to support ground water objectives. Because the primary objective of ground water monitoring is the protection of surface water, these locations are monitored most like AOC wells.

One surface water location in Pond B-2 is monitored in coordination with the CDPHE. VOCs have been detected previously at this location (POM3). Contaminants in surface water in Pond B-2 may represent residual contamination in the South Walnut Creek drainage that pre-dates the installation of the ETPTS, or a portion of the East Trenches Plume bypassing the ETPTS intercept trench.

Surface water station SW018, which is located in the unnamed tributary to North Walnut Creek downgradient (west-northwest) of IHSS 118.1, is also monitored in support of ground water objectives. This IHSS was identified because of historical spills of carbon tetrachloride. The IHSS was remediated via source removal in 2004, but the associated plume of VOC-contaminated ground water persists. To assess whether this plume is impacting surface water, SW018 is monitored for VOCs.

Decisions associated with these locations are similar to those for AOC wells (Figure 3−3). See Appendix B for summary information on monitoring requirements.

Decision Statement:

IF	Measured concentrations of a VOC AoI exhibit a statistically significant increasing trend at 95 percent confidence (Criterion 1), AND the 85th percentile of the data is greater than the larger of the corresponding surface water standard or PQL (Criterion 2), OR Most recently measured concentration of a VOC AoI exceeds the WRW SWPRG (Criterion 3) AND concentrations above WRW SWPRG in the prior sample are confirmed by the current sample—
THEN	If there has been no prior ground water evaluation addressing these observations, or these observations indicate the prior evaluation was not adequate, perform a ground water evaluation and implement findings—
ELSE	Determine whether monitoring may be terminated.

IF	Monitoring is required at any wells (of any class) in the source area directly upgradient—
THEN	Continue monitoring the surface water support location—
ELSE	Perform data record comparisons, using Criteria 1, 2, and 3 above.

IF	Upgradient wells are no longer monitored and measured concentrations in the surface water support location do not meet any of Criteria 1, 2, or 3—
THEN	Review conditions with regulatory agencies and exit monitoring by analyte suite, as appropriate, following results of the preceding comparisons—
ELSE	Continue monitoring.

3.3.9.2 Sentinel Wells

Sentinel wells are located near downgradient edges of contaminant plumes, in drainages, at ground water treatment systems, and along contaminant pathways to surface water. These wells will be monitored to determine whether concentrations of contaminants are increasing, providing advance warning of potential ground water quality impacts to downgradient AOC well(s). Confirming this will require an analytical record that consistently indicates an impact, not a single data point that indicates a contaminant has been detected.

Confirmation of a potential ground water quality impact will be documented and discussed in the subsequent CERCLA Periodic Review. This discussion will include an assessment for the need to perform a ground water evaluation or other follow-up action.

Problem Statements:

Are contaminants detectable, increasing or decreasing in concentration with time, or showing the potential to impact surface water? Do additional data from source-area wells indicate ground water monitoring may cease?

Problem Scope:

Sentinel wells are used to monitor the performance of an accelerated action (including soil/source removals, in-situ contaminant plume treatment, ground water intercept components of treatment systems, and facility demolitions) and to assess contaminant trends at important locations. Data from Sentinel wells are supplemented by those from Evaluation wells, and are used to determine when monitoring can cease or additional remedial work should be considered.

Data Types and Frequencies:

- Surface water ALs;
- Uranium threshold (see Figure 3−1);
- Selected analyte suites including the AoIs, based on historical data (see Appendix B);
- Well-specific historical data for AoIs;
- Statistically derived, well-specific historical data trends for AoIs;
- Field parameters;
- Water levels; and
- Ground water quality data for upgradient wells.

Boundaries:

Spatial:	Sentinel wells are located along contaminant pathways to surface water, in drainages, and around ground water treatment systems. Decisions will be made on the basis of the upgradient plume(s) monitored by each Sentinel well.
Temporal:	Sentinel wells will be sampled semiannually, during the second and fourth calendar quarters. Data will be reviewed and reported semiannually. If

reported results fail specific Sentinel well criteria (Figure 3−4), data from the well and upgradient wells will be reviewed and discussed in the subsequent CERCLA Periodic Review; any action that may be identified as necessary (e.g., a ground water evaluation) shall be identified in that Review. Other decisions will be made as data are available. The well network will be reviewed (and revised, if necessary) a minimum of once every five years. Review of data to determine whether monitoring may cease will be performed as analytical results approach exit requirements; once monitoring has ceased, corresponding data reviews, data reporting, and monitoring decisions will no longer be performed.

Decision Statement:

IF	Measured concentrations of an AoI other than U (see Figure 3−1) in the current suite are on a statistically significant increasing trend at 95 percent confidence (Criterion 1), AND the 85th percentile of the data is greater than the larger of the corresponding surface water standard or PQL (Criterion 2)—
THEN	Review data from the Sentinel well and upgradient wells. Identify possible causal factors and conditions. Propose actions that may either alleviate these factors and conditions, or would characterize them adequately for the appropriate action to be identified. Report data and present causes and proposed actions in subsequent CERCLA Periodic Review—
ELSE	Determine whether monitoring may be terminated.

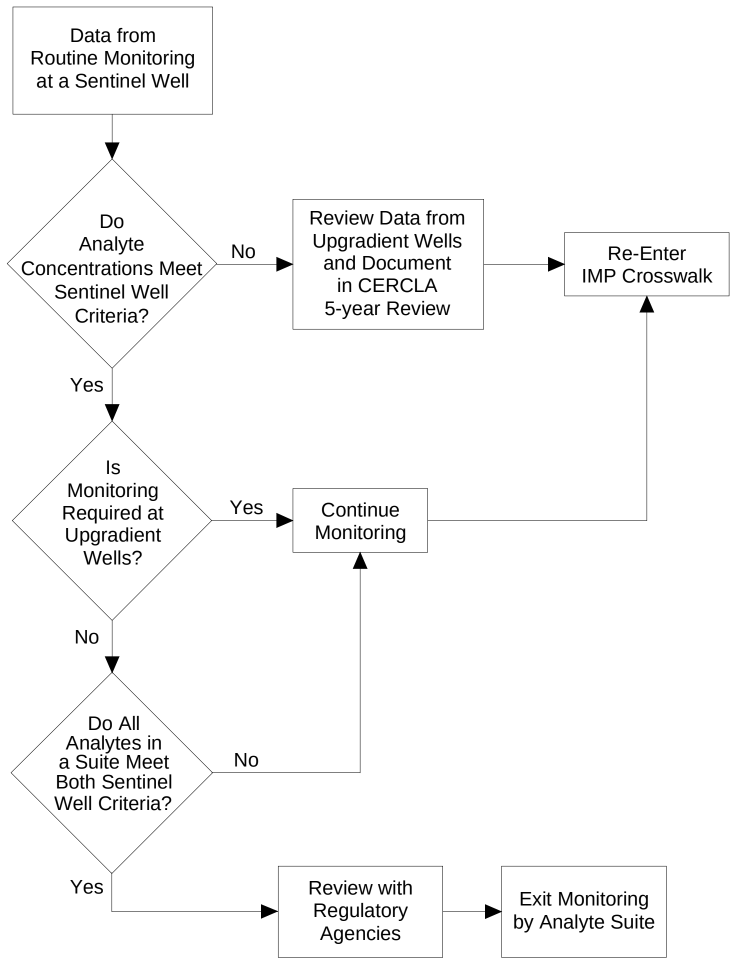
IF	Monitoring is required at any upgradient wells of any class—
THEN	Continue monitoring Sentinel well—
ELSE	Perform data record comparisons, using Criteria 1 and 2 above.

IF	Measured concentrations in well do not meet either Criteria 1 or 2—
THEN	Review conditions with regulatory agencies and exit monitoring by analyte suite, as appropriate following results of the preceding comparisons—
ELSE	Continue monitoring.

Figure 3−4 presents a decision flowchart for Sentinel monitoring wells.

3.3.9.3 Evaluation Wells

Evaluation wells are located within ground water contaminant plumes and near plume source areas, and within the interior of the former IA at RFS. Data from Evaluation wells indicate whether conditions in these areas are improving over time, thereby helping to determine when monitoring of an area or plume can cease. Data from these wells also assist appraisals of predictions made through ground water modeling efforts.



- Sentinel wells are sampled twice every year.
- See Figure 3-1 for decisions related to uranium.

Sentinel Well Criteria (Analyte-specific; EITHER must be met.)

1. The 85th percentile concentration of an analyte *is less than or equal to* the corresponding surface water standard.
2. Analyte concentrations exhibit an indeterminate or statistically significant *decreasing* trend at the 95% confidence level.

Figure 3–4. Sentinel Wells

Evaluation wells also support ground water evaluations. The specific DQOs identified for Evaluation wells in such a circumstance will be devised during the preparation of the corresponding ground water evaluation, and therefore are not presented here.

Problem Statements:

Do contaminant concentrations suggest steadily changing conditions at source areas? Is Site closure affecting ground water conditions as predicted by modeling?

Problem Scope:

Evaluation wells are located primarily in ground water contaminant plumes and near or immediately downgradient of contaminant source areas. As such, they may monitor the effects of accelerated actions that have been performed (e.g., source removal, in-situ treatment). Data from these Evaluation wells are therefore appropriate to determine whether monitoring of a particular plume and source area can cease, and to provide data to support the determination of whether ground water plume treatment systems can be decommissioned. In addition, Evaluation wells are used to support any ground water evaluations that may be needed as a result of changing contaminant characteristics in downgradient Sentinel and/or AOC wells.

Evaluation wells are also located within the interior of the former IA and in areas that may experience changing ground water conditions as a result of Site closure activities. Data from these wells, as well as data from Evaluation wells used to support ground water evaluations, will be considered as they are received. Specific DQOs for these purposes are not discussed here because they cannot be adequately anticipated. These DQOs will be devised whenever necessary to support any specific needs that have arisen.

Data Types and Frequencies:

- Surface water ALs;
- WRW SWPRGs;
- Selected analyte suites including the AoIs, based on historical data (see Appendix B);
- Well-specific historical data for AoIs;
- Statistically derived, well-specific historical data trends for AoIs;
- Field parameters; and
- Water levels.

Boundaries:

Spatial: Decisions will be made on an individual well basis, and will support decisions on a contaminant-plume or source-area basis.

Temporal: Evaluation wells will be sampled every other year (biennially) during the second calendar quarter. These data will be reviewed and reported biennially (i.e., data from a group of Evaluation wells will be reviewed and reported the same year they are collected). Specific Evaluation wells will also be sampled if necessary to support a ground water evaluation at a specific Sentinel or AOC well. These data will be reviewed as part of that evaluation and reported within 6 calendar months of completion of the evaluation. Decisions will be made at the same frequency (biennially as well as following an evaluation, if applicable). The well network will be reviewed (and revised, if appropriate) at least once every 5 years. Review of data to determine whether monitoring may cease will be performed as analytical results approach exit requirements; once monitoring has ceased, corresponding data reviews, data reporting, and monitoring decisions will no longer be performed.

Decision Statement:

IF	Measured concentration of any analyte in current suite in Evaluation well exceeds WRW SWPRG—
THEN	Continue monitoring—
ELSE	Determine whether monitoring may be terminated.

IF	Measured concentrations in well exhibit a statistically significant decreasing trend at the 95 percent confidence level, OR The 85th percentile of the data is less than the greater of the corresponding surface water standard or PQL—
THEN	Review conditions with regulatory agencies and exit monitoring by analyte suite, as appropriate following results of the preceding comparisons—
ELSE	Continue monitoring.

Figure 3−5 presents a flowchart for Evaluation monitoring wells.

3.3.9.4 RCRA Wells

The wells monitoring the Present Landfill and Original Landfill are collectively referred to as RCRA wells. The monitoring requirements and decisions differ for these two groups of wells, but are generally similar. See Appendix B for well-specific monitoring requirements.

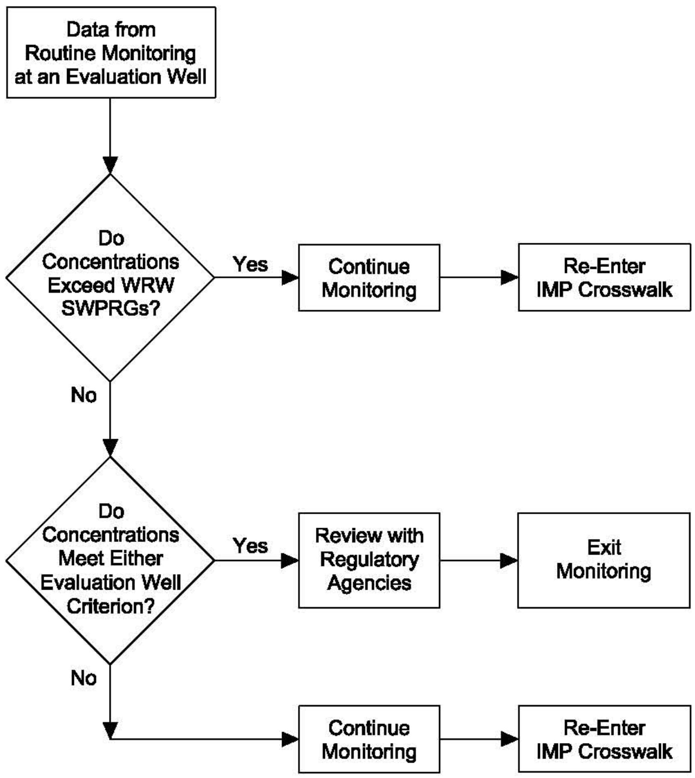
Problem Statements:

Present Landfill: Are mean concentrations in downgradient wells statistically different from those of upgradient wells? Do concentrations show a significant increasing trend?

Original Landfill: Are mean concentrations in downgradient wells statistically different from those of upgradient wells? Do data from downgradient wells consistently exceed surface water standards, with a significant increasing trend?

Problem Scope:

The Present Landfill and Original Landfill will be monitored in accordance with the decision documents that apply to these areas; the associated wells are classified as RCRA wells, although those at the Original Landfill are also evaluated using criteria that are not typical for RCRA wells.



- Evaluation wells are sampled once every two years.

Evaluation Well Criteria (Analyte-specific; EITHER must be met.)
1. The 85th percentile concentration of an analyte is *less than or equal to* the corresponding surface water standard.
2. Analyte concentrations exhibit a statistically significant *decreasing* trend at the 95% confidence level.

Figure 3–5. Evaluation Wells

Data Types and Frequencies:

- Concentrations of landfill-specific AoIs;
- Well-specific historical data for AoIs;
- Statistically derived, well-specific historical data trends for AoIs;
- Surface water standards;
- Field parameters; and
- Water levels.

Boundaries:

Spatial: Present Landfill. Decisions will be made based on pooled results of upgradient wells and on an individual well basis in downgradient wells, if there are sufficient downgradient data, else a pooled downgradient data set may be used.

Spatial: Original Landfill. Decisions will be made based on results of the upgradient well and on an individual well basis in downgradient wells, if there are sufficient downgradient data, else a pooled downgradient data set may be used; and on comparisons of downgradient data with surface water standards.

Temporal: Analytical data are collected and reported quarterly. Data will be reviewed and upgradient/downgradient comparisons made annually.

Decision Statements:

Present Landfill:

IF Mean concentration in a downgradient RCRA well (or group) significantly exceeds (at 95 percent confidence) the mean concentration in upgradient RCRA wells, AND concentration trends at the downgradient RCRA well (or group) have an up trend significant at 95 percent confidence—
THEN Consult RFCA Parties and determine appropriate response—
ELSE Continue monitoring.

Original Landfill:

IF Mean concentration in a downgradient RCRA well (or group) significantly exceeds (at 95 percent confidence) the mean concentration in upgradient RCRA well,
OR
85th percentile concentrations at one or more downgradient wells exceed surface water standards AND concentrations of this analyte at this well have a significant up trend at 95 percent confidence—
THEN Consult RFCA Parties and determine appropriate response—
ELSE Continue monitoring.

Figure 3−6 presents a flowchart for RCRA monitoring wells.

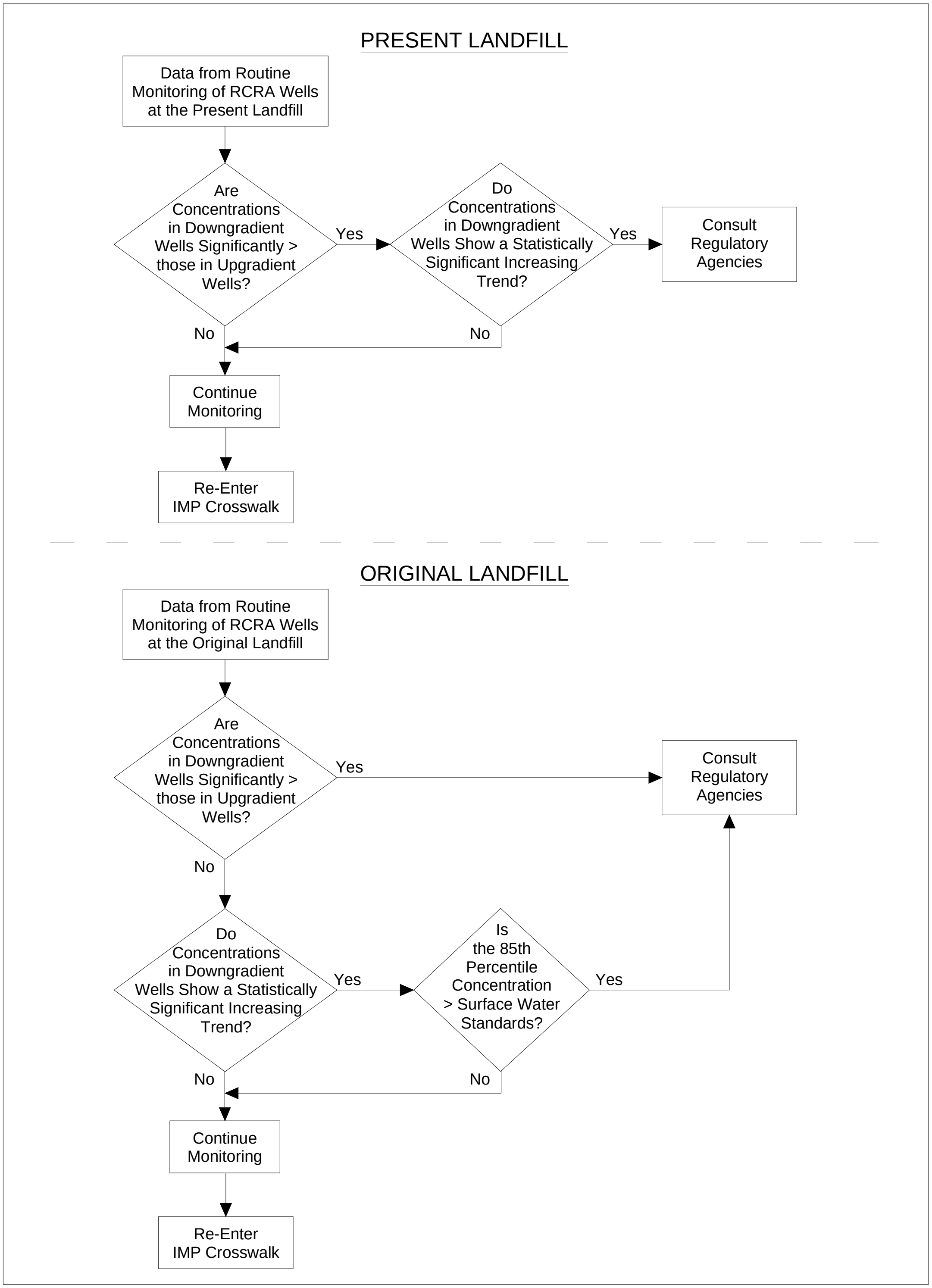


Figure 3–6. RCRA Wells

3.3.9.5 Boundary Wells

Boundary wells monitor UHSU ground water at the east boundary of RFS. Historically, RFS has monitored wells at the east boundary to provide the surrounding cities with assurance that there are no contaminants in alluvial ground water leaving RFS. Two Boundary wells are retained to confirm ground water leaving the Site in the Walnut Creek and Woman Creek drainages is not adversely impacted by the Site. These wells are located at the intersection of these drainages and Indiana Street.

Problem Statement:

Is UHSU ground water at the downstream boundary of the Site adversely impacted?

Problem Scope:

Contaminated UHSU ground water is present within the central portion of the Site. This ground water discharges to surface water prior to leaving the Site. Boundary wells confirm that this ground water flowing off the Site is not contaminated by historical Site activities.

Data Types and Frequencies:

- Surface water ALs;
- Uranium threshold (see Figure 3−1);
- WRW SWPRGs;
- Selected analyte suites including the AoIs, based on contaminants observed upgradient (see Appendix B);
- Well-specific historical data for AoIs;
- Statistically derived, well-specific historical data trends for AoIs;
- Field parameters;
- Water levels; and
- Ground water quality data for upgradient wells.

Boundaries:

Spatial: UHSU ground water in the drainages at the Indiana Street boundary. Decisions will be made on an individual well basis.

Temporal: Wells will be sampled, and data will be reviewed and reported annually and decisions will be made annually.

Decision Statement:

IF Measured concentrations of an AoI other than U (see Figure 3−1) in the current suite exhibit a statistically significant increasing trend at 95 percent confidence (Criterion 1), AND the 85th percentile of the data is greater than the larger of the corresponding surface water standard or PQL (Criterion 2),
OR

	Most recently measured concentration of an AoI exceeds the WRW SWPRG (Criterion 3) AND concentrations above WRW SWPRG in the prior sample are confirmed by the current sample—
THEN	If there has been no prior ground water evaluation addressing these observations, or these observations indicate the prior evaluation was not adequate, perform a ground water evaluation and implement findings—
ELSE	Determine whether monitoring may be terminated.

IF	Monitoring is required at any upgradient wells (of any class)—
THEN	Continue monitoring the Boundary well—
ELSE	Perform data record comparisons, using Criteria 1, 2, and 3.

IF	Upgradient wells are no longer monitored and measured concentrations in the Boundary well do not meet any of Criteria 1, 2, or 3—
THEN	Review conditions with regulatory agencies and exit monitoring by analyte suite, as appropriate, following results of the preceding comparisons—
ELSE	Continue monitoring.

Figure 3−3 presents a flowchart for Boundary monitoring wells.

3.3.9.6 Decision Document Wells

Wells and piezometers that support ground water monitoring requirements related to ground water plume treatment systems, as identified in their respective decision documents (DOE 1997, DOE 1999a, DOE 1999b), are monitored as Sentinel wells, Water Level wells, or Decision Document wells, as described in Section 3.3.9. In general, locations that the Ground Water IMP Working Group recommended be retained in the network beyond FY 2005 are assigned the former classifications; with several exceptions, only those wells required by applicable decision documents but not recommended for the future network are assigned the Decision Document classification. (Exceptions include wells monitoring water levels at the Mound, East Trenches, and Solar Ponds systems, which are all assigned Water Level classification; and monitoring well 51605, the replacement for well 1386, which is assigned Sentinel classification rather than the Working Group-recommended Evaluation classification.)

The OU1 CAD/ROD wells will be monitored differently, as described below.

A plume of contaminated ground water referred to as the OU1 Plume is present on the 881 Hillside near the southeastern boundary of the former IA. VOCs constitute the primary contaminants. The source of contamination is IHSS 119.1, a former drum and scrap metal storage area.

The OU1 Plume is relatively small and well defined. Migration is confined by a paleochannel and limited by degradation of contaminants (DOE 2001a). As a result, the plume has not migrated south to impact surface water (either the SID or Woman Creek).

In 1997, a CAD/ROD was implemented to address this plume and associated controls, including a French drain, collection well, and treatment system. This CAD/ROD was modified in 2001 and currently defines the ground water monitoring of this plume. During the development of the

FY 2005 IMP, the Ground Water IMP Working Group recommended changes to the monitoring specified in this document. However, until those changes are formally implemented and approved in a new modification to the CAD/ROD, the monitoring specified in the 2001 CAD/ROD will be performed. The decision statement below is taken from the CAD/ROD (DOE 2001a) and modified to reflect the replacement of well 891COLWEL with 891WEL.

Problem Statement:

Do concentrations of trichloroethene (TCE) in ground water from well 891WEL exceed RFCA Tier I Action Levels? Are concentrations of contaminants in ground water from wells 891WEL and 0487 below RFCA Tier II Action Levels?

Problem Scope:

Two wells identified by the OU1 CAD/ROD (891WEL and 0487) are within the plume. Four are on the downgradient edge of the plume. These wells are monitored to ensure that concentrations of contaminants in the plume are not increasing, and that the plume is not migrating to surface water.

Data Types and Frequencies:

- Selected analyte suites based on historical data (see Appendix B);
- RFCA Tier I and Tier II Ground Water Action Levels for these constituents;
- Current, well-specific data for AoIs;
- Well-specific historical data for AoIs;
- Field parameters; and
- Water levels.

Boundaries:

Spatial: UHSU ground water in the OU1 plume as defined by the six wells specified in the OU1 CAD/ROD (DOE 2001a).

Temporal: The two wells within the plume (891WEL and 0487) will be monitored quarterly and the other four wells (4787, 4887, 10992, and 11092) will be monitored semiannually. Data will be reviewed and reported quarterly and decisions will be made annually. Monitoring will be evaluated during the periodic CERCLA reviews.

Decision Statement:

IF Concentrations of TCE in well 891WEL exceed RFCA Tier I Ground Water Action Levels during the current and three prior consecutive sampling events—

THEN Evaluate impacts to surface water and determine if an action (such as resumption of pumping and treating water from this well) is necessary—

ELSE Continue monitoring all six wells.

IF	Concentrations of all contaminants in wells 891WEL and 0487 are less than RFCA Tier II Ground Water Action Levels during the current and three prior consecutive sampling events—
THEN	Discontinue monitoring all six wells—
ELSE	Continue monitoring all six wells.

Figure 3−7 shows a flowchart for CAD/ROD wells.

3.3.10 Data Quality Objectives for Monitoring Ground Water Treatment System Monitoring Points

Contaminated ground water is intercepted and treated in three areas of the Site. The ground water intercept trenches are similar to a French drain with an impermeable membrane on the downgradient side. Ground water entering the trench is routed through the drain pipe into a treatment cell, where it is treated and is then discharged to surface water. (Note: A treatment system is also present at the Present Landfill, but is addressed separately in Section 2.3.1.1.)

The three systems include the MSPTS, ETPTS, and SPPTS. The MSPTS was installed in 1998, and the other two were installed in 1999. Each system features at least two sample collection points that enable the collection of, at a minimum, untreated influent entering the treatment cells and treated effluent exiting the cells. While these samples may not strictly represent ground water, the monitoring of these systems is included in the Ground water section of the IMP. Monitoring decisions also depend on surface water quality at designated “performance monitoring” locations downgradient of the discharge area of each treatment system. Because the DQOs associated with these surface water locations support the ground water treatment systems, they are addressed in this section rather than the Surface Water Monitoring portion of this IMP (Section 2.0).

Monitoring requirements and decisions applicable to these systems are presented in Figure 3−8.

Problem Statements:

Are upgradient, “source-area” wells no longer monitored and do influent concentrations indicate treatment is no longer necessary? Do effluent concentrations indicate treatment systems are operating satisfactorily? Do surface water concentrations indicate impacts to surface water?

Problem Scope:

The MSPTS and ETPTS are monitored for influent and effluent water quality and downgradient surface water quality; the SPPTS is monitored for influent, effluent, and system discharge water quality, and downgradient surface water quality. Impacts to surface water are evaluated through effluent and surface water data. If concentrations of the influent fall below surface water standards AND monitoring of the upgradient source-area (Evaluation) wells is no longer required, the system may be decommissioned. (The standards that will be used for this comparison are the underlying standards, not any temporary modifications that may be in effect.)

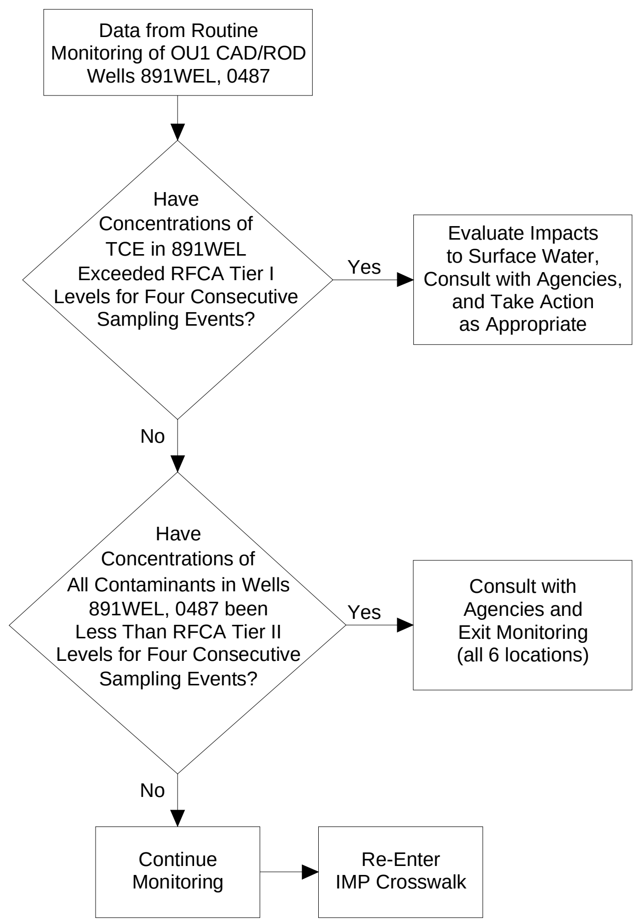
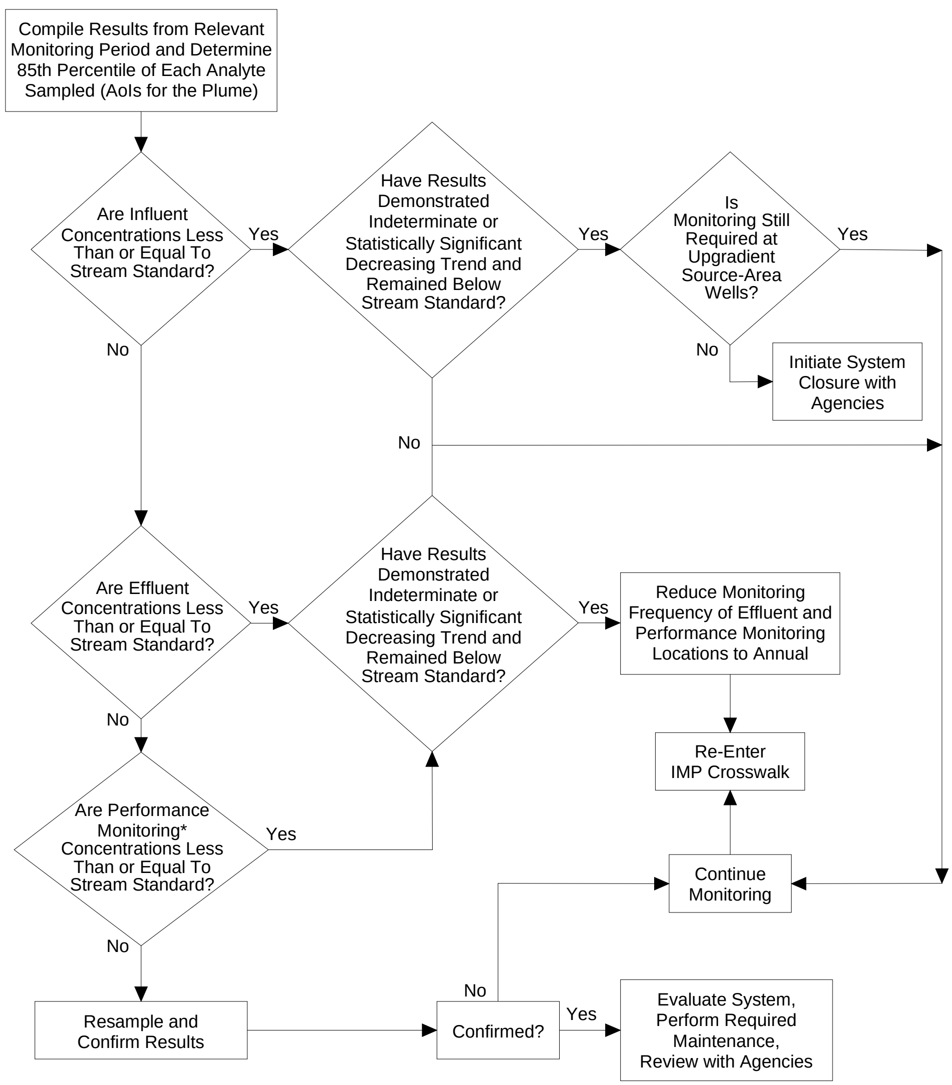


Figure 3–7. Corrective Action Decision/Record of Decision Wells



- Treatment system monitoring is performed twice every year.

* Performance monitoring locations that apply are in surface water, and are as follows: Surface water location GS10 for MSPTS; Surface water location POM2 for ETPTS; and Surface water location GS13 for SPPTS.

Figure 3–8. Treatment Systems

Data Types and Frequencies:

- Selected analyte suites based on contaminants in the plumes being treated (see Appendix B);
- Surface water standards for these constituents;
- Current, location-specific data for AoIs;
- Location-specific historical data for AoIs;
- Field parameters;
- Treatment system and surface water flow conditions; and
- Whether monitoring of upgradient source-area wells is still required.

Boundaries:

Spatial:	For each treatment system, contaminated ground water is sampled in the upgradient source area and at the influent point, treated water is sampled at the effluent point, and surface water is sampled downgradient of the point at which effluent is discharged to surface water. In addition, at the SPPTS, discharged effluent is sampled.
Temporal:	Treatment system locations are monitored semiannually, source-area locations (Evaluation wells) are monitored biennially. Data will be reviewed and reported semiannually and decisions will be made annually.

3.3.11 Data Quality Objectives for Monitoring Ground Water Flow

Data on ground water quantity and the magnitude and direction of ground water flow are necessary to assess the effects of RFS closure and historical operations on surface water quality. Compiling water-level information from wells supports the following routine analyses:

- Assessment of the potential impact of contaminant plumes on surface water quality through the creation of potentiometric surface maps from which horizontal hydraulic gradient and flow direction can be derived; and
- Evaluation of the ground water monitoring network's effectiveness, using the ground water flow directions and contaminant plume information to ensure critical data gaps do not exist.

These data can also support the following analyses, should they be necessary:

- Evaluation of impacts to downgradient habitat and endangered species caused by changes in ground water recharge to fluvial systems as a result of RFS closure and remediation activities;
- Calculation of contaminant mass flux and loading to a surface water receptor that may be impacted by a ground water plume; and
- Development of ground water flow and contaminant transport models to assess the effect of ground water contamination on surface water.

Problem Statement:

Has Site closure altered ground water flow directions to the extent that important contaminant pathways are not adequately monitored, or have a decreased or increased potential to impact surface water?

Problem Scope:

The water table within the UHSU (comprising alluvium and other unconsolidated surficial materials, together with the underlying weathered portion of the bedrock) responds to seasonal and event-related changes in recharge. Water-level data are used to determine hydraulic gradients, which define ground water flow directions. Interpretations of the fate and transport of contaminants, and potential effects of ground water on surface water and wetlands, depend on knowledge of the hydraulic gradient, the saturated thickness of the aquifer, and the hydraulic conductivity of the geologic materials through which the ground water flows.

Ground water flow directions are subject to change after Site closure activities altered surface and subsurface conditions. For example, the removal of impervious surface structures such as roads, parking lots, and buildings affects runoff and local recharge; the removal or grouting of underground utilities affects flow paths; and the elimination of the water supply system affects local recharge. Post-closure flow directions, reflecting these and other closure-related changes, were estimated using modeling techniques (*Site-Wide Water Balance Report*, Kaiser-Hill 2002a). Water-level data collected from the ground water monitoring network will be assessed to ensure that there are no critical data gaps in the network.

Data Types and Frequencies:

- Historical water-level data;
- Historical Site configuration and infrastructure information (buildings, parking lots, etc.);
- Contaminant plume and surface water configurations;
- Modeled flow directions from the *Site-Wide Water Balance Report* (Kaiser-Hill 2002a);
- Meteorological data; and
- Current water levels.

Boundaries:

Spatial: All wells in the network will be monitored for water levels. Water Level wells are located in selected areas to fill what would otherwise be data gaps in the flow monitoring network.

Decisions will be made on an area-specific basis. Water-level data from a single well are not particularly useful for flow monitoring; data must be compared to corresponding data from other wells in the area.

Temporal: Water levels will be measured and the resulting data collected automatically from many locations. (Some of the other locations monitor ground water with elevated concentrations of contaminants, which might adversely affect automated down-hole equipment.) Where data are collected automatically, they will be collected at least once weekly. Where water levels are measured manually, measurements will be performed at least semiannually, during the second and fourth calendar quarters, to generally coincide with analytical sampling. This minimum frequency will be increased if appropriate (for example, to support quarterly sampling around the Present Landfill). Manual collection of water-level data shall be performed during the first 5 calendar days of the appropriate calendar quarter, before any ground water sampling activities for that quarter have begun. Data will be reviewed and reported semiannually. Decisions will be made semiannually.

Decision Statement:

IF	Potentiometric surface maps indicate flow directions are changing unexpectedly with time—
THEN	Review monitoring network for data gaps that may result from these changes—
ELSE	Continue taking measurements.

IF	Critical data gaps result from changes in flow directions—
THEN	Consult with appropriate parties and revise monitoring network as appropriate—
ELSE	Continue taking measurements.

IF	Hydraulic gradients within a contaminant plume continue to change unexpectedly over the course of any 2-year period—
THEN	Evaluate and report possible impacts to surface water; implement action as appropriate—
ELSE	Continue taking measurements.

IF	Analytical samples are not required at the well or the next downgradient well, and there is no other reason to continue water-level measurements (e.g., due to requirements in a decision document)—
THEN	Consult with the appropriate parties and revise monitoring network as appropriate—
ELSE	Continue taking measurements.

Figure 3−9 shows the flowchart for flow monitoring.

3.4 Quality Control Objectives for Collection/ Evaluation of Ground Water Data

General requirements for the Ground Water Monitoring Program activities are covered under the *Legacy Management CERCLA Sites Quality Assurance Project Plan* (LM QAPP; DOE 2006d) and associated SOPs. The LM QAPP is consistent with the QA program requirements of DOE Order 414.1C, *Quality Assurance* (DOE 2005a), and environmental data operations requirements in EPA QA/R-5, *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA 2001) and ANSI/ASQ E-4-2004, *Quality Systems for Environmental Data and Technology Programs: Requirement with Guidance for Use* (ANSI/ASQ 2004). The

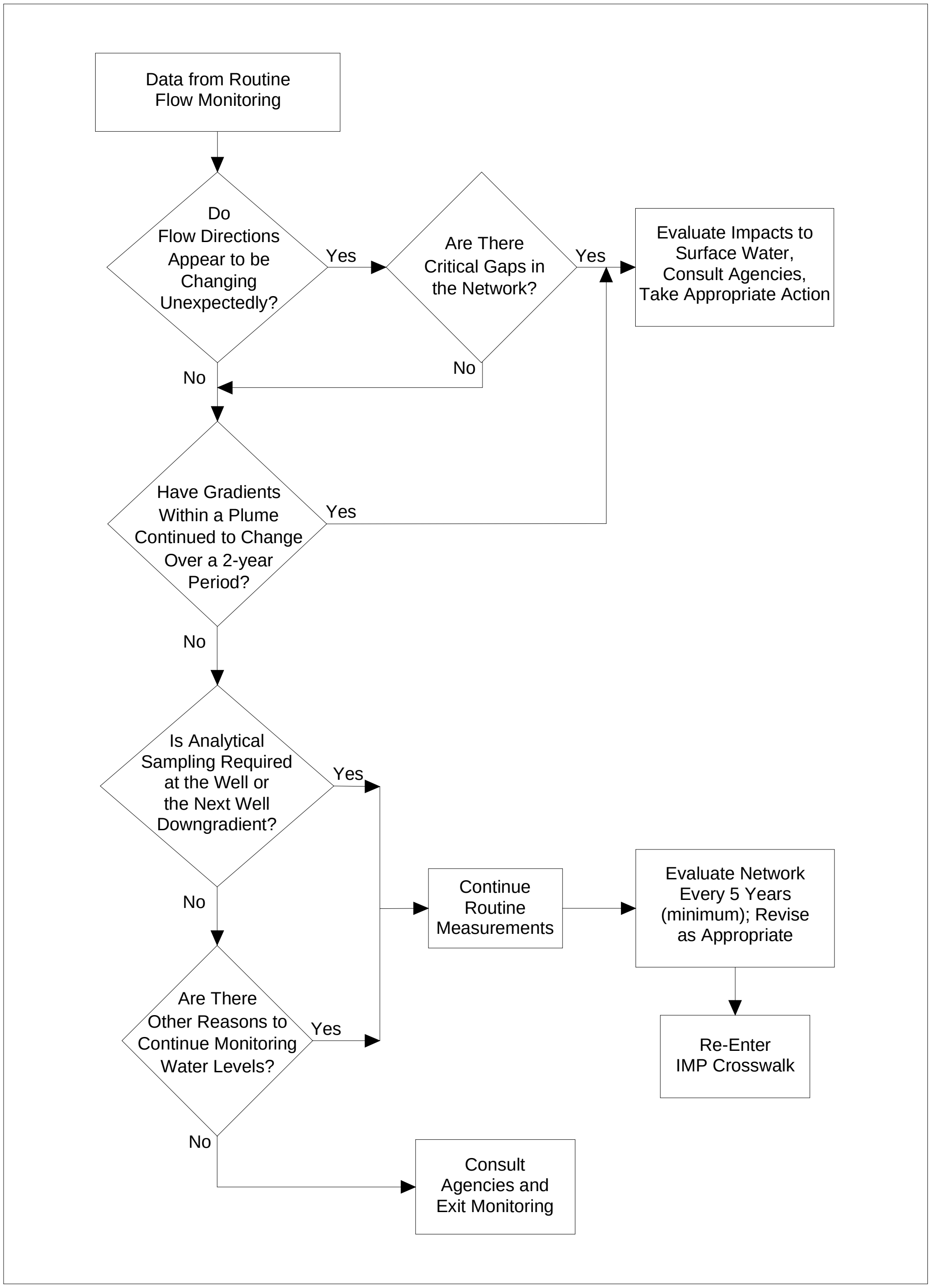


Figure 3–9. Flow Monitoring

Program covers environmental activities and describes the requirements, methods, and responsibilities of environmental management, staff, contractors, and vendors for achieving and ensuring quality. The LM SAP (DOE 2006e) presents the methods by which ground water monitoring is performed at the Site. Non-routine evaluations and special sampling projects will be governed by task-specific work plans, SAPs, or other work control documents.

The LM QAPP generally covers QC for the following components of the ground water program:

- Developing DQOs;
- Collecting and analyzing samples according to approved procedures; and
- Reducing, reporting, and managing data and records in a controlled manner.

3.4.1 Field Data Collection

QC objectives for the collection of field parameters and representative samples of ground water are established to ensure that data are of sufficient quality to support the decisions identified in the previous section. The QC objectives for field data collection are the following:

- Sampled water is representative of UHSU ground water;
- Sampling techniques do not introduce contaminants into samples or wells;
- Sampling techniques are generally standardized for improved reproducibility and comparability of results; and
- Water elevations are measured precisely enough to detect minor fluctuations (+/-0.01 foot) in the water table.

The applicable task-specific SOPs ensure that quality samples are collected for use in environmental decision making.

3.4.2 Data Management

Prior to Site closure, ground water monitoring field data and laboratory analyses were maintained in the SWD. This is a relational database that stored environmental data collected at RFS. Since Site closure, those data have been moved to a new database, to which all new data are appended; this database is called SEEPro. Data analysis and reporting now use data extracted from SEEPro instead of SWD.

SEEPro uses Oracle® software for data management and Microsoft® Access for data retrieval and display. It compiles water quality, field parameter, sample tracking, sample location, and water level data for ground water, surface water, boreholes, soils, and sediment samples. Field parameter data include such information as sample location, sample date, pH, turbidity, conductivity, and temperature. Chemical information (CAS registry numbers, analytical results, and detection limits) is also included. Specific procedures for verification of database information received from subcontractors, or input directly into SEEPro, are followed. These procedures provide QA documentation, which ensures that available data have been incorporated and entered or uploaded properly into SEEPro. Data integrity is maintained with standardized error checking routines used when loading data into SEEPro. Other procedures address database system security and software change control.

The RFS field data are entered through the FieldPar field data entry system. This system is a data entry module that is compatible with the SEEPro database, and is used in the office by field personnel. Data entered into FieldPar are verified by the sampler before loading into the main SEEPro database.

Spatial information for ground water data features are located in the LM GIS database. Some of the ground water data features included are potentiometric surfaces, plume configurations, topographic contours, and historical RFS facilities. This system uses an ESRI® ArcGIS™ suite of software to store and present data. Well locations and other sample location data features are derived from location information stored in the SEEPro database.

3.5 Description of the Ground Water Monitoring Program Resulting from the DQO Process

Ground water monitoring is an essential component of surface water protection at RFS because Site-impacted ground water is discharged to surface water within RFS boundaries. The overall objective is to identify contaminated ground water and associated pathways to surface water, and to protect those resources from further or potential damage.

Elements of the program include measurement of hazardous constituent concentrations in ground water, determination of the gradient and direction of ground water flow, and assessment of the nature and extent of contaminant plumes in the UHSU within RFS boundaries. The monitoring network is designed to monitor areas of known or potential ground water contamination based on composite ground water plume information and OU-specific source characterization activities compiled over the past two to three decades, together with Site closure strategies.

The monitoring well network should undergo constant evaluation—even after Site closure—to determine the most effective approach to monitoring ground water at RFS. This evaluation should take into account current regulations and agreements, but, more importantly, it should integrate new data and technical information on ground water flow conditions and the nature and extent of contamination.

The Ground Water Monitoring Program for 2006, until the final Site CAD/ROD and LTS&MP are issued, comprises the following monitoring components:

- A network of 126 wells and 12 other locations (treatment system monitoring points, surface water locations) will be monitored;
- Of these 138:
  - 12 wells will be sampled quarterly (four times yearly),
  - 58 locations will be sampled semiannually (twice yearly),
  - 2 wells will be sampled annually, and
  - 40 wells will be sampled biennially (once every two years);
- Water levels will be measured at least semiannually at 126 wells, including at 26 wells reserved solely for this purpose;

- Three ground water treatment systems and at least one associated surface water location for each system will be monitored; and
- The network will comply with decision documents that identify ground water monitoring in support of the three treatment systems and OU1.

Samples for the analysis of plutonium and americium (Pu/Am) are included in the analytical suite for several of the wells that will be sampled semiannually and that are located downgradient of Buildings 371 and 771. These data will be used to confirm that closure of those facilities has not impacted downgradient ground water with these radionuclides.

Ground water monitoring for Pu and Am is included in response to community concerns. There is no sound technical reason for this monitoring. As summarized in the Ground Water IM/IRA (Kaiser-Hill 2005b), field studies at RFS by unaffiliated technical experts have demonstrated that particulate- and colloid-facilitated transport of Pu and Am is the dominant mechanism for occurrence in shallow ground water. As a result, by migrating through the geologic materials that comprise the UHSU, Pu and Am that may be present on particulates and colloids is filtered out. This is confirmed by the fact that Pu and Am ground water contamination is generally not found in areas outside of surface soil contamination areas. This observation is consistent with the hypothesis that soil contamination that is carried down boreholes during drilling and well installation activities has caused misleading detections of Pu and Am in ground water. Sample results from "aseptic" wells (which were constructed so as to minimize the potential for soil contamination to enter the borehole, and which were paired with traditionally constructed wells that produced ground water samples with elevated Pu and Am) demonstrate that Pu and Am are detected in shallow ground water at RFS in the femtocurie (fCi; one quadrillionth, or 10^{-15}, of a curie) per liter range.

Additional program elements include:

- Updating and proposing changes to the Ground Water Monitoring Program;
- Quarterly data evaluation and reporting to the appropriate regulatory and community agencies;
- A well installation, maintenance, abandonment, and replacement program; and
- Performing ground water evaluations.

The ground water monitoring network includes the following six monitoring well classifications and two special groups of monitoring locations:

- AOC: 7 wells plus 2 Surface Water Support locations;
- Sentinel: 32 wells;
- Evaluation: 40 wells;
- Boundary: 2 wells;
- RCRA: 10 wells;
- Decision Document: 9 wells;

- Water Level: 26 wells (including 18 wells monitored solely to support decision documents); and
- Ground Water Treatment System: 10 monitoring points.

During development of the FY 2005 IMP, the Ground Water IMP Working Group recommended the monitoring performed to comply with decision documents be changed when those documents are revised, modified, or superseded. At the SPPTS, one well (51605, which replaces 1386) is recommended as an Evaluation well, but because the monitoring frequency specified in the corresponding decision document is semiannual, it is currently assigned the Sentinel well classification. Numerous wells at the three ground water treatment systems (four at the SPPTS, three at the ETPTS, and 11 at the MSPTS) are classified as Water Level wells, but are not recommended for retention in the long-term monitoring network. The other wells monitored to comply with decision documents are classified as Decision Document wells, and were not recommended by the Ground Water IMP Working Group for retention in the long-term monitoring network. At the SPPTS this includes two water quality wells (70099 and 1786); and at the MSPTS this includes one water quality well (3586).

Changes are also recommended to the monitoring that is performed in accordance with the OU1 CAD/ROD. This document specifies the monitoring of six wells, which are included in this IMP as a single group of six Decision Document wells. Two of the six (891WEL, which replaces 891COLWEL, and 0487) are monitored quarterly, and the other four (4787, 4887, 10992, and 11092) are monitored semiannually. The Ground Water IMP Working Group recommended that this six-well network be replaced with two wells: 891WEL, located in the source area, as an Evaluation well; and new well 89104, located downgradient of the plume near Woman Creek, as an AOC well. However, until the OU1 CAD/ROD is formally modified, the six wells identified above will continue to be monitored in accordance with the January 2001 modification to the OU1 CAD/ROD (DOE, 2001a). To simplify tracking and recordkeeping for these six CAD/ROD wells, they are not grouped with other classifications based on their sampling frequency (i.e., with RCRA and Sentinel wells, which are monitored quarterly and semiannually, respectively).

The ground water plume treatment system monitoring points and additional surface water monitoring locations are another special group of sampling locations that are not monitoring wells, but rather influent to and effluent from ground water treatment cells, corresponding surface water receptors downstream of the effluent discharge, and surface water locations associated with a treatment system (in the case of POM3, at the ETPTS) or VOC source removal (in the case of SW018, downgradient of IHSS 118.1).

Well classifications and the list of wells and other monitoring locations comprising the ground water monitoring network are presented in Appendix B.

3.5.1 Ground Water Monitoring Network

The DQO evaluation process has been used to design the Ground Water Monitoring Program and to determine the specific decisions for each well that is monitored. The general premise is that each well should provide data for one or more decisions or actions that are prompted when set criteria are met. Ground water monitoring data are acted on if they exceed specified criteria defined above or, in the process of monitoring termination, when results fall below those criteria.

Historical data, Site knowledge, and the consultative process have been used to identify the wells in the monitoring network and to determine which contaminants are of major interest in RFS ground water. The analyte suites tested for in ground water samples from current monitoring wells include the identified AoIs.

The action-level threshold concentrations used in this and the FY 2005 IMP differ from the RFCA and other Site-specific levels used in the past, and vary depending on well classification, as discussed in Section 3.3.3.

Major AoIs were determined through reviews of historical ground water data that have been performed over the years; for example, in the development of Annual RFCA Ground Water Monitoring Reports. These data reviews provided knowledge of the locations and types of ground water contamination having the potential to impact surface water at the Site. Monitoring wells in the network were selected based on their location with respect to these areas of ground water contamination and contaminant source areas, and on well construction. AoIs for RCRA wells were selected in consultation with representatives of the regulatory agencies.

Analytical suites were defined for each well on a well-specific basis. Factors considered in the determination of the analyte suite for a given well included process knowledge, historical sampling results, the location of the well with respect to contaminant plumes or source areas, the corresponding contaminants, whether and what type of other contaminants might be upgradient of the well, the ground water flow direction in the vicinity of the well, the proximity of the well to a surface water receptor, and the well's classification. As with AoIs, analytical suites for RCRA wells were defined in consultation with agency representatives.

The location of each well with respect to contaminant sources, contaminant plumes, and surface water receptors formed the basis by which the frequency of sampling was defined. Wells within source areas, higher-concentration portions of plumes, and within the interior of the IA were generally assigned the Evaluation classification and a biennial (once every two years) sampling frequency. Wells at downgradient plume edges and in drainages were generally assigned either Sentinel or AOC well classifications and a semiannual (twice yearly) sampling frequency. Wells at the Site boundary were assigned an annual sampling frequency. The RCRA wells and Decision Document wells retained their required sampling frequencies, as did the ground water treatment system monitoring points.

Appendix B contains the analyte suites that will be collected for each well, the well classifications, and the monitoring frequency.

3.5.2 Ground Water Sampling and Analysis

The ground water sampling network contains 126 wells, including 26 wells that will be monitored for water level only. The network also includes 12 other sampling locations that represent monitoring points in the ground water treatment systems and surface water monitoring locations. Appendix B lists the wells and other locations in the monitoring program along with their IMP classification.

Appendix B also lists the sampling frequency for locations in the monitoring program. As noted above, the frequency of sampling varies from quarterly (four times per year) to biennially (once every 2 years), depending on well classification. Wells that are sampled semiannually will be sampled during the spring and winter quarters (second and fourth calendar quarters, respectively) because these generally represent high and low water conditions at the Site. Data from these wells will therefore reflect a broad range of conditions. Wells scheduled for annual sampling will be sampled during the spring quarter, as will wells scheduled for biennial sampling.

Guidelines for the collection of ground water samples are provided in the LM SAP, Rev. 8 (DOE 2006e). Basic requirements include:

- Ground water samples will generally be collected using peristaltic pumps, bladder pumps, or freshly decontaminated, reusable bailers. Bailed wells will be purged and sampled gently so as to reduce the agitation caused by the use of a bailer.
- Filtered samples will be collected for samples to be analyzed for total U; unfiltered samples will be collected for VOC and nitrate analyses. At the RCRA wells, unfiltered samples will be collected for VOC and SVOC; and filtered samples will be collected for the analysis of metals. In accordance with previous agreements, samples for the analysis of Pu/Am will not be filtered. (Therefore, because the concentration of suspended solids is directly correlated with Pu/Am activities reported in ground water samples from areas of Pu/Am soil contamination, the turbidity of the sample water must be as low as practicable.)
- Field parameters that will be measured include temperature, pH, specific conductance, turbidity, and total alkalinity. These will be measured during the purging process and will be used to confirm the completion of purging.
- If limited ground water sample volumes prevent analysis of the full suite assigned to a given well, samples for analysis generally will be collected in the order defined below. (Note that many of the listed analytes are only collected at a very few locations. Refer to Appendix B for well-specific analytical suites.)
    1) VOCs,
    2) SVOCs,
    3) Nitrate,
    4) Metals,
    5) Total U,
    6) Plutonium-239/240, americium-241, and
    7) Gross alpha and gross beta.

The order in which analytical samples are to be collected may be altered to fit statistical needs or for specific wells/areas.

3.5.3 Measurement of Ground Water Elevations

Preparation of water elevation maps and hydrographs addresses both a regulatory requirement and a technical need to know ground water flow directions and gradients accurately. The measurement of ground water elevations, also referred to herein as water levels, has been designed to produce data that are as representative of current conditions as possible.

Ground water elevations will be measured using two types of equipment. Many wells will be equipped with downhole pressure transducers and dataloggers. Ground water elevations are determined by these units through the measurement of the water pressure on the transducer, which is then converted to the feet of water under which the transducer is submerged. At the few wells where ground water contamination could cause degradation of the cables with which these units are equipped, ground water elevations will be measured manually, using an electric sounder. The sounder will be used to measure the depth of the water level in the well with respect to the top of the inner well casing on its north side.

Regardless of the method by which ground water elevations are measured, these data will be collected at least semiannually, within the first 5 working days of the second calendar quarter and fourth calendar quarter. This will make certain that the data are as temporally related as possible. If data are required more frequently, the same 5-day limit will apply unless well- or area-specific DQOs require otherwise. (For example, at the RCRA wells, ground water elevations will be measured at least quarterly, during the first five working days of each quarter.)

Ground water elevations will be measured in all 100 wells identified for analytical sampling, plus 26 wells selected to provide only ground water elevation data. These wells are identified in Appendix B.

3.5.4 Ground Water Reporting

Ground water activities will be reported throughout the life of the monitoring program. The communication to responsible parties, as outlined in the DQO decision statements in Section 3.3, will be accomplished at various levels of formality depending on the nature of the activity.

In 2006, until and unless the Site CAD/ROD reduces the network in accordance with recommendations from the IMP Working Group, 100 wells will be sampled. Most will be sampled in either the second or fourth calendar quarter, or both. Twelve wells will be sampled quarterly, so the first and third quarters will have few sampling results to report.

Prior to Site closure, Quarterly RFCA Ground Water Monitoring Reports were issued. Subsequent to closure, Quarterly Reports of Site Surveillance and Maintenance Activities will be issued, which will contain a summary of ground water monitoring data collected in the respective period at RFS. (Quarterly Reports for the first and third calendar quarters will be abbreviated, as indicated above.) These Quarterly Reports of Site Surveillance and Maintenance Activities will also contain text on other routine activities at the Site, such as surface water monitoring, erosion control, ecological monitoring, inspection reports, etc. The data will be officially transmitted to EPA and CDPHE by DOE. Summaries will be presented quarterly at public information exchange meetings. Resuming in 2006 (for the 2005 year), Annual RFCA Ground Water Monitoring Reports will be produced. The ground water content in the Quarterly Reports of Site Surveillance and Maintenance Activities is required for the ground water program based on the integration of past regulatory requirements with the RFCA ALF.

The DQOs set forth in this document specify varying frequencies at which ground water data are to be collected and assessed. Semiannual data reviews are most commonly required. Therefore, a semiannual assessment of ground water conditions will be performed and reported except for those wells or areas requiring a different frequency.

Future Quarterly Reports of Site Surveillance and Maintenance Activities will incorporate data elements that were historically reported in the Quarterly RFCA Ground Water Monitoring

Reports. The Annual Reports will incorporate data elements that were historically reported in the Annual RFCA Ground Water Monitoring Reports, the RCRA Annual Ground Water Reports, the occasional Well Evaluation Report, and the occasional IM/IRA Report. These two reports and will be the only regularly scheduled reports for ground water data. Quarterly Reports of Site Surveillance and Maintenance Activities will generally contain the following elements:

- Analytical data collected during the 3-month reporting period.
- Statistical analysis of any data warranting this analysis, and comparisons described in Section 3.3.
- Annual Reports will generally contain the following elements:
- A general description of the various monitoring program elements, including new ground water monitoring activities.
- Interpretations of the data. The focus of the interpretations will be on areas of change, unanticipated conditions, and, as appropriate, areas in which impacts to surface water may be occurring or in which surface water may be potentially threatened.
- RFS ground water flow as interpreted through analysis of water-level data collected during the reporting periods. Included will be potentiometric surface maps for the second and fourth quarters. As appropriate, for areas experiencing unexpected changes in potentiometric conditions possibly related to Site closure or increased potential for surface water impacts, hydrographs will be included and discussed.
- Recommendations for improvements to the monitoring program that may include changes in the well network, analytes collected, and sampling frequency.
- An assessment of data quality, including field QC and laboratory QC results. These assessments will be performed on all water analytical data as a group (i.e., ground water as well as surface water) to provide a more comprehensive assessment of data quality.

The Quarterly Reports of Site Surveillance and Maintenance Activities will be submitted to DOE in the third month following the conclusion of the reporting period (e.g., the report representing the first calendar quarter [January, February, and March] is due in June of that year).

3.5.5 Evaluation of Ground Water Impacts To Surface Water

The primary purpose of monitoring the ground water at RFS is to protect surface water quality. The Site's hydrologic setting, particularly its low ground water flow rates and the physical separation of shallow, Site-impacted ground water from deeper ground water resources, leads to relatively well-contained ground water contamination. However, because Site-impacted ground water discharges to surface water before leaving the Site, monitoring the ground water between contaminant plume edges and surface water is particularly important.

Special investigations may be implemented under this IMP and RFCA in response to indications of increased contaminant concentrations that may have the potential to impact surface water. These projects are referred to as ground water evaluations, and are typically of limited duration and focused scope. Their primary purpose is to investigate the observed conditions, identify possible causes, and estimate the potential impact on surface water.

Ground water evaluations will be designed to respond to a specific water quality concern. Each will be implemented under a project-specific SAP, work plan, or other work control document. That document will identify the specific DQOs, data collection methods and locations, and follow-up actions that apply to the existing circumstances. Ground water evaluations shall be identified and developed in coordination with the regulatory agencies if negative surface water impacts are indicated.

In most or all cases, a preliminary data review will be performed immediately upon recognition of a potential concern. The results may be sufficiently clear to indicate a cause of the given concern without need for additional sampling and analysis. In such cases, the regulatory agencies will be notified and discussions will be held to ensure all parties are informed of the conclusions reached through the reviews.

3.5.5.1 General Strategy for Ground Water Plume Management

The existence of ground water contaminant plumes (e.g., VOC, uranium, nitrate) at RFS has been well documented. The *Groundwater Conceptual Plan for the Rocky Flats Environmental Technology Site* (RMRS 1996) presents a summary of the known information on individual ground water plumes and possible remedial actions. The contents of this document are updated in the *Interim Measure/Interim Remedial Action for Groundwater at the Rocky Flats Environmental Technology Site* (Kaiser-Hill 2005b).

For purposes of implementing the IMP, the following template serves as a unifying policy for plume management and decision making for ground water plumes under the IMP and aids in the integration of ground water functions into closure planning at RFS.

The plume management strategy for RFS will consist of the following components.

Detection:

The detection of ground water contamination that could impact surface water at RFS is supported through the current water monitoring programs at RFS as well as through historical data from past investigations and information on past contaminant spills. The Surface Water and Ground Water Monitoring Programs have been established to detect the migration of contaminants into water that could move off Site. The monitoring programs are dynamic and may be changed to accommodate new insights into contaminant migration. The maintenance of historical data in SEEPro (and formerly in the SWD and the HRR [DOE 1992a]) help provide information on potential ground water contamination problems.

The AOC, Sentinel, and Boundary well classifications and their respective decisions have been specifically designed to protect surface water quality, and to allow the response to a potential impact to surface water to be measured and to correspond to the magnitude of the threat.

If a threat to surface water is detected and confirmed in an AOC or Boundary well, a ground water evaluation is required. If such a threat is seen in a Sentinel well, an evaluation may be proposed through the CERCLA Periodic Review process.

Trend testing and the 85th percentile of the data, as described in Section 3.3.3, ensure that perceived threats to surface water are real and give an indication of their magnitude. At AOC and

Boundary wells, if results are confirmed to exceed the WRW SWPRGs, an urgent response is directed without the need to accumulate the data necessary to meet the requirements of trend testing or 85th percentile comparisons.

Section 3.3 of the 2006 IMP presents the DQOs that establish the methods of detection and the actions that will follow.

Evaluation:

The DQO decisions for ground water monitoring at AOC and Boundary wells, and potentially also at Sentinel wells, require that an evaluation be performed to assess potential impacts to surface water caused by ground water contamination. In general, the ground water evaluation will begin by generating focused DQOs that will determine the type of data that needs to be collected, and the methodology for determining the nature and extent of contamination and its effect on surface water.

An evaluation of surface water impact may include, but not be limited to, any or all of the following possible components:

- Review of historical data from the well reporting the data that indicate a potential surface water impact and other wells nearby (including abandoned wells if appropriate);
- Review of the HRR (DOE 1992a) to identify possible sources of the contamination observed at the well;
- Inspection of the area surrounding and upgradient of the well to investigate for visible physical changes that could be factors in the reported data;
- Contaminant fate and transport modeling;
- Definition of extent of contaminants and/or the contaminant pathway through additional sampling of soil, ground water, surface water, and/or seeps, and through additional well or borehole installations;
- Measurement or estimation of contaminated ground water flow velocity, flow direction, and discharge to surface water;
- Measurement of surface water flow rate in the area of the impact;
- Measurement of the area of surface water directly impacted by the contaminated ground water;
- Determination of nature and extent of ecological impact from contaminated ground water discharging to a surface water receptor;
- Determination of concentration loadings and mass flux of contaminants to the surface water receptor; and
- Estimation of impacts due to seasonal variations, discharges, or removal of ground water collection systems.

Each evaluation will be defined by unique DQOs that will consider such factors as relative impact, priority, and risk to the public. This approach will identify areas with the highest potential for surface water contamination. Once a significant impact to surface water has been identified, the findings will be provided to DOE, which will establish or update priorities for further action. As warranted, the scope will be promulgated as an accelerated action, PAM, or an IM/IRA. Where modeling results form part of the basis of decisions, it is assumed that these predictive components of the evaluation will be weighed against actual field data in setting the priority for action.

Remedial Decision Validation:

Additional ground water monitoring may be required to validate the efficacy of a remedial action or the no-action alternative. Performance monitoring will consider both the short-term and the long-term protection of surface water. A DQO process will be employed to establish a performance monitoring system. The Quarterly Reports of Site Surveillance and Maintenance Activities will track the long term results of the monitoring activities and recommend changes if necessary.

3.5.5.2 General Strategy for Performance Monitoring

As previously noted, monitoring wells in the network are generally selected to address one or more DQOs. In some cases, these DQOs include monitoring the performance of an accelerated action. For example, several wells monitor downgradient of source removals; and several other wells monitor downgradient of the intercept trenches of ground water treatment systems. The general purpose of these monitoring wells, as applied to performance monitoring, is to confirm the remedy is operating as intended.

This section addresses monitoring specific on-Site remedial activities for the release of contaminants to the environment. In general, performance monitoring relates to a soil accelerated action or a ground water plume treatment remedy. As the Site has closed, additional project-specific performance monitoring is not anticipated. However, if it is necessary it will be detailed in a decision document or project plan through the review and approval process when the project poses a concern for a specific contaminant release, especially for a contaminant that may not be adequately monitored by other monitoring objectives. Each performance monitoring location will target the contaminants of greatest concern for the specific action being monitored.

For projects that require performance monitoring, a combination of historical data review and field walkdowns are conducted to further assess potential monitoring locations. Wherever appropriate, existing monitoring stations will be used to achieve monitoring goals.

The following strategic questions have been developed to determine if additional performance monitoring is needed.

- Which projects require monitoring? (Specifies those accelerated actions that need independent performance monitoring.)
- Where should these projects be monitored? (Specifies the existing or proposed monitoring locations needed to adequately observe project impacts.)
- When should monitoring begin? (Specifies the collection of initial baseline samples, if feasible and appropriate.)
- What is the analyte suite? (Specifies the AoIs associated with a specific project.)

- How should monitoring be performed? (Specifies flexible design of sample collection method intended to confidently monitor for changes in water quality.)
- How will a problem be recognized? (Specifies well classification-based decisions and threshold criteria.)
- What are the reporting requirements and follow-up actions to be taken? (Specifies that RFS will evaluate a specific project to improve performance if monitoring shows negative change in water quality.)

The template below has been developed around these fundamental questions and poses a series of detailed questions to guide the process for evaluating candidate projects, assessing specific performance monitoring needs (i.e., where, when, and what), communicating these requirements to DOE, and assisting in the determination of sampling and analysis requirements for inclusion in the project plan, as well as implementation of the performance monitoring/reporting process. It should be reiterated that no new performance monitoring is anticipated; this process is presented in case unexpected conditions are observed after Site closure.

Template for Performance Monitoring

I. Monitoring Location Selection
   A. Selection Of Projects To Be Monitored
      Consider project-specific risks to surface water
      - Scope of activities
      - History of project area

      Consider project duration
      - Sufficient time to collect adequate data for evaluation purposes
      - When will monitoring begin and end based on project schedule? Consider relative risks

   B Selection Of Project Ground Water Locations To Be Monitored
      Identify ground water pathways for project
      - Determine ground water flow direction
      - Identify any subsurface structures (basement, sub-basement, foundation drain, utilities, etc.) that may impact ground water flow
      - Determine if there is a ground water plume present in project area

      Determine source(s) of potential contamination
      - Identify former IHSS(s) that may contribute contamination
      - Determine contaminant distributions and concentration gradients within area IHSS(s)
      - Determine whether the potential contaminant source(s) poses a significant risk to surface water
      - Can monitoring at existing sample locations serve as an alternative?

II. Data Requirements
   A. Analytes Of Interest
      Consider history of project area
      Consider scope of project

B. Field Data Collection

Types and frequency of information needed

- Determine optimal frequency of water-level measurement
- Determine optimal sampling frequency
- Identify appropriate sampling methods
- Consider field parameters and other information required

C. Installation Requirements

Consider logistical and design requirements

- Evaluate whether existing monitoring facilities can perform the desired monitoring
- If new monitoring equipment is required, ensure it will not interfere with other ongoing activities or conditions
- Determine level of effort required to implement monitoring
- Evaluate risk required to implement monitoring and ensure effort is warranted
- Identify best location(s) for monitoring
- Determine depth of well(s) with respect to potential contaminant pathway(s)

III. Data Evaluation

A. Determine Changes In Water Quality At Specific Location With Applicability To Specific Sources

Statistically compare new data points against old data points

- Upgradient/Downgradient/Baseline Comparison; consider persistence
  a) IF new data point is not significantly different from old data points incorporating additional corresponding information, THEN continue monitoring
  b) IF new data point is significantly different from old data points incorporating additional corresponding information AND indicates an adverse change, THEN initiate notification/action process
- Does the specific event pose a significant risk to surface water?

B. Notification Process

Schedule/time table

To be determined

Hierarchy/personnel involved

- Project Managers will be notified first
- DOE will be notified next
- Regulatory agencies will be notified next

Notification items

- Nature of anomalous event
- Constituents involved
- Suspected source(s) where constituents may have originated
- Other?

C. Action Determination

Determine potential impact to surface water

- Estimate direction and magnitude of contaminant to reach surface water; incorporate consideration of hydrologic conditions and indicator parameters
- Track progress of plume using ground water and/or surface water locations
- Estimate contaminant fluxes and loads if necessary

Verify activity/location responsible

- Based on event characteristics
- Based on suspected area where constituents may have originated

Determine potential mitigating actions

- Based on identified activity/location responsible
- Based on event characteristics, constituent
- Based on relative levels of effort to implement potential mitigating actions
- Based on risk to surface water that could be mitigated
- Prioritize mitigating actions considering delays to other high priority risk reduction activities

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This template will be applied in an integrated fashion where ground water contamination is of concern. The selection of appropriate monitoring locations for flow measurement and sampling will be determined in conjunction with the planned configuration of the ground water monitoring network. The integrated ground water performance monitoring design package, in the form of a proposed work plan, SAP, or project plan, will be delivered to the appropriate project manager or other responsible entity for review. Data analysis and evaluation techniques will be in accordance with the IMP. Monitoring results will be reported in RFCA ground water reports and data will be accessible in SEEPro and the GEMS webpage.

3.5.6 Well Control Program

The Well Control Program tracks well and piezometer installations. The program supports the following activities:

- Assigning well location codes to eliminate misidentification of wells or use of redundant well names.
- Maintaining a database with summary well information to be used for evaluation of the functions of new wells, and preparing and obtaining well permits if required by 2 CCR 402-2 regulations.
- Maintaining a database of well construction information and geologic log information that must be submitted with the permit applications, if necessary.
- Submitting permits for wells that are installed or abandoned to the State Engineer's Office, if necessary.
- Maintaining the RFS geologic core log file for use in correlation of geologic strata and interpretation of hydrogeologic properties.
- Ensuring that wells are installed following applicable procedures and with appropriate knowledge of geologic and RFS conditions.

3.5.7 Well Abandonment and Replacement

Monitoring wells have been installed at RFS since 1954, with a total of over 1,450 wells installed since the 1950s. Periodically over the years, obsolete and unnecessary wells were abandoned. Since FY 2002, abandonment activities worked toward a closure status in which the only wells remaining upon Site closure would be those monitored through the IMP. This effort was completed in FY 2005, with the exception of seven wells along Rock Creek in the northern

Buffer Zone that were to be transferred to USFWS and several piezometers used to monitor dam safety. In all, over 1,300 wells were removed.

Only wells determined to be no longer necessary for ground water monitoring purposes will be abandoned. Properly abandoning a well eliminates it from the monitoring network in such a manner that the well will not remain a conduit for ground water or contaminant migration. Wells are abandoned in accordance with 2 CCR 402-2 regulations. Where needed for the network, wells that are damaged or not appropriately constructed for long-term monitoring are replaced. Proper abandonment of wells is required under the following circumstances:

- When the potential for cross-contamination from the well exists;
- When the well is poorly constructed or damaged;
- When the well is in the way of proposed activities; and
- When the well has no identified purpose for future monitoring.

End of current text

4.0 Air Quality Monitoring

4.1 Introduction

During active Site closure, the Air Quality Management (AQM) group within Kaiser-Hill's Environmental Systems and Stewardship (ESS) organization oversaw activities prompted by federal and state regulations established pursuant to the federal CAA and its amendments, and by DOE orders. Within this framework, AQM historically operated effluent, ambient, and meteorological monitoring programs. Additional air monitoring has historically been performed by CDPHE or coordinated by DOE. Currently only limited ambient air monitoring is performed, along with collection of meteorological data from a nearby representative location.

The air quality program goal is to provide a means to quantify and characterize the effects of Site activities on air quality. As Site closure reached completion, air monitoring program scope reduction closely followed Site infrastructure decommissioning.

4.1.1 Air Monitoring Objectives and Regulatory Drivers

In the past, the air monitoring program at RFS has included ambient, effluent, and meteorological monitoring activities. As of September 2005, only ambient monitoring is performed by the Site, although representative meteorological data continue to be gathered from the National Renewable Energy Laboratory (NREL) at a location adjacent to the Site. Ambient monitoring will continue for some period of time following completion of accelerated actions, as described in Section 4.2.2. Regulatory drivers pertinent to ambient and meteorological monitoring include:

- Ambient Monitoring:
  - No Longer Applicable Since No Facilities Exist at the Site: 40 CFR 61, Subpart A "General Provisions," Subpart H "National Emission Standards for the Emissions of Radionuclides Other Than Radon From DOE Facilities" (Rad-NESHAP), and Appendix B (Note: ambient monitoring is performed as an alternative compliance demonstration method under Subpart H);
  - No Longer Applicable as Above: Colorado Air Quality Control Commission (CAQCC) Regulation No. 8, Part A, Subpart A, "General Provisions," and Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities;" and
  - DOE Orders 5400.1, *General Environmental Protection Program* (DOE 1988), and 5400.5, *Radiation Protection of the Public and the Environment* (DOE 1990).
- Meteorological Monitoring:
  - No Longer Applicable as Above: 40 CFR 61, Subpart H and CAQCC Regulation No. 8, Part A, Subpart H (meteorological observables used as input to dispersion modeling, if necessary);
  - DOE Order 5400.1-IV; 2.4, *General Environmental Protection Program* (DOE 1988); and
  - DOE Order 414.1B, *Quality Assurance* (DOE 2004a).

Effluent monitoring has been discontinued as facilities entered active decommissioning, an activity characterized by conditions that prevent accurate quantification of emissions due to factors such as the loss of building infrastructure that supports effluent sampling, unpredictable variability in effluent flows as ductwork and plenums are decommissioned, and radiological postings that prevent access to effluent samplers. All Site buildings that were historically subject to effluent monitoring have been demolished, and the effluent monitoring program has been terminated.

Ambient monitoring of radionuclides at the Site perimeter is performed by subcontracted Site personnel. Ambient monitoring is required by DOE orders and has been approved for demonstrating compliance with Rad-NESHAP standards. Ambient data can be used in human health risk assessment evaluations of OU closure. Ambient monitoring data are also used to validate dispersion modeling projections of future air quality. In addition, ambient data from the Radioactive Ambient Air Monitoring Program (RAAMP) are used to confirm that emission controls are operating as intended, under the DOE directive to keep doses to receptors as low as reasonably achievable by maintaining administrative and physical control of potential sources of radiological emissions.

On-Site meteorological monitoring historically supported both Rad-NESHAP reporting requirements and the emergency response requirements of DOE orders. Representative meteorological data are downloaded from NREL files of data collected at the M2 tower, located approximately 1 mile due north of the former RFS meteorological tower. M2 tower data are queried by Site staff as needed.

In cooperation with the surrounding communities, DOE previously implemented a four-station Community Radiation (ComRad) Monitoring Program. In 1992 and 1993, independently operated monitoring stations were installed in the communities of Arvada, Westminster, Broomfield, and Northglenn. Ambient concentrations of Pu, meteorological data, and gamma radiation data have been collected continuously using monitoring protocols comparable to those at RFS. As Site closure was nearing completion, the ComRad stations were shut down, with three of the four stations discontinued by mid-September 2005. The remaining station will remain as an outreach tool, with no operating equipment.

4.1.2 RFS Air Monitoring Scope

Figure 4−1 illustrates the current perimeter RAAMP sampler locations. As many as 25 other locations existed during the 12 months prior to the completion of demolition activities at the Site in October 2005. Once the demolition and soil disturbance activities had been completed, the network was no longer needed for Rad-NESHAP compliance demonstration purposes or for project-specific monitoring. DOE has continued monitoring at locations S-132, S-136 and S-138 to monitor expected changes in downwind air quality as the soil weathers; the other locations were removed from service. S-136 and S-138 sample the air quality predominantly downwind of the Site; S-132 captures mainly ambient non-Site emissions on the predominantly upwind side of the Site.

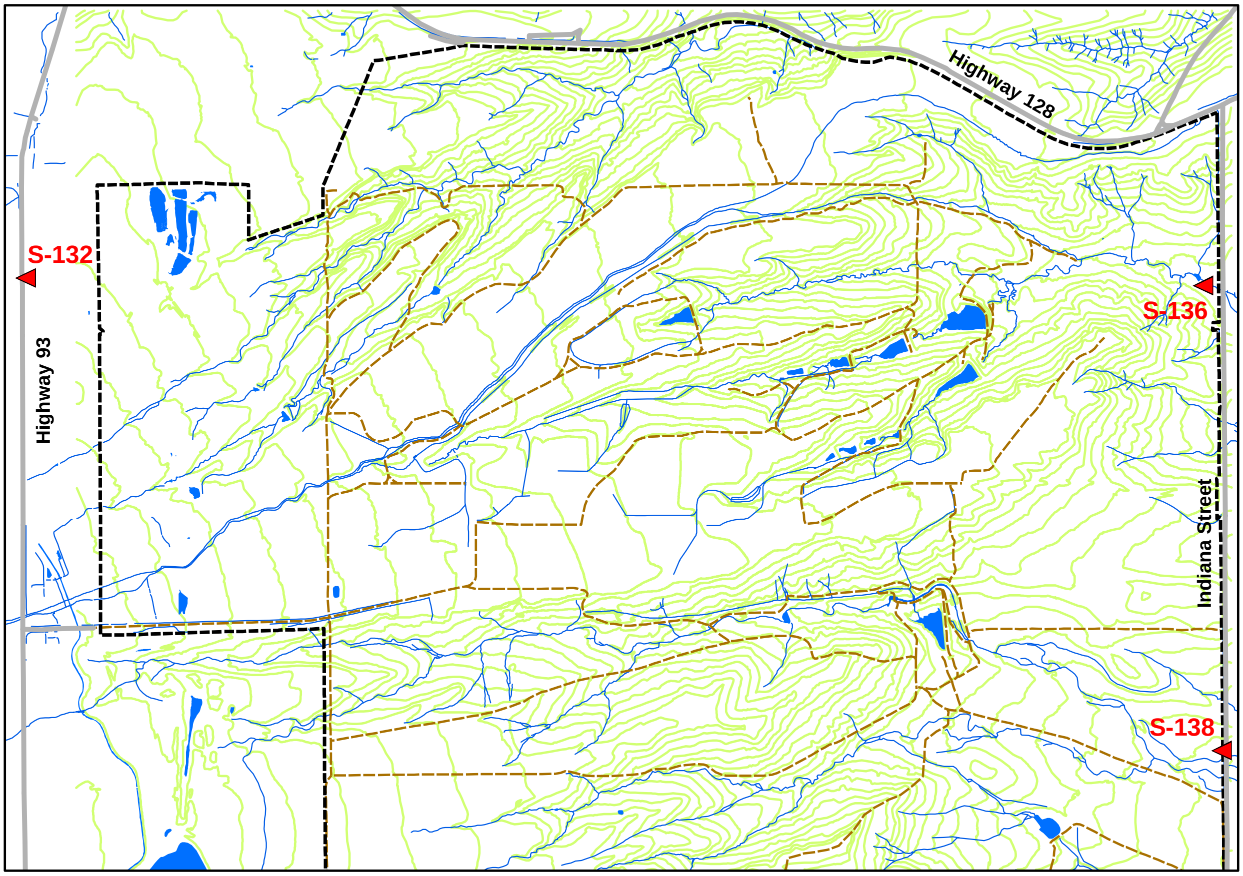

Figure 4–1. Rocky Flats Air Sampling Location Map

The RAAMP samplers monitor dispersed airborne radioactive particles from RFS in the surrounding environment. These samplers, located at several historically key locations on the Site perimeter, are used to demonstrate compliance with Rad-NESHAP standards. Samplers operate continuously at a volumetric flow rate of approximately 40 cubic feet per minute (ft^3/min) (1.13 cubic meters per minute [m^3/min]), collecting airborne particles on two collection surfaces. Coarse, non-inhalable particles (larger than about 10 micrometers aerodynamic equivalent diameter) are collected on an oiled impactor surface; fine, more readily inhalable particles (smaller than 10 micrometers) are collected on glass fiber filters. The paired, size-partitioned samples are analyzed independently to characterize differences in radioparticulate partitioning between inhalable and non-inhalable airborne particles.

Collection substrates are exchanged monthly. Substrates from the samplers are digested, then subjected to radiochemical separation and alpha spectral analysis, which quantifies specific alpha-emitting radioisotopes. Analyses are performed for specific isotopes of Pu, U, and Am.

4.2 Ambient Air Monitoring

After all demolition and remediation projects had been completed at RFS (post-accelerated action), no buildings or other facilities now exist and no activities are anticipated that would have the potential to produce significant quantities of airborne radionuclide emissions, including fugitive dust emissions. The only potential source of Site-derived airborne radionuclides is low concentrations of residual contamination that remain in the surface soil as allowed under the closure agreement. Under these Site conditions, ambient air monitoring is continued by DOE voluntarily for some period of time to confirm low emissions. Ambient monitoring is being performed at three existing locations (Figure 4−1). Two of these locations are situated in the downwind direction under prevailing higher speed winds and in locations where typically the highest potential dose has been estimated through modeling using representative meteorological conditions at the Site. The third location is situated west of the Site, and will be used to compare predominantly upwind radionuclide air concentrations to concentrations at downwind locations.

Monitoring is performed at existing RAAMP sampler locations S-136, S-138, and S-132 (see Figure 4−1). Samplers S-136 and S-138 are both located on Indiana Street. The choice of these locations is consistent with recommended siting criteria for alternative ambient monitoring as provided in EPA's *Guidance on Implementing the Radionuclide NESHAPs*, Appendix A, Section 2.1 (EPA 1991). This guidance states that facilities with continuous emissions should have critical receptor locations at the location of the greatest impact on the facility perimeter fenceline, or at the location of the highest off-site impact where a residence exists. These two fenceline locations typically have provided the highest ambient concentrations of Site-derived radionuclides under operating conditions that represent continuous emissions from fugitive sources. Location S-136 is in relatively close proximity to a residence near the corner of Indiana Street and Highway 128; fenceline location S-138 is along an air pathway between the 903 Pad cleanup area and areas near several residences to the east-southeast of that cleanup area. Location S-132 is along Highway 93, north of the Old Tyme Lumber Sawmill entrance (11218 Highway 93) and near extensive gravel mining operations.

Data Types and Frequencies:

- Monitored concentrations of Pu-239/240, Am-241, U-233/234, U-235, and U-238 at three RAAMP samplers; and
- Quality assurance of monitoring data.

Boundaries:

Spatial: Two RAAMP samplers sited at the location of the greatest impact on the facility perimeter fenceline, or at the location of the highest off-Site impact where a residence exists. One RAAMP sampler sited in a prevailing upwind location.

Temporal: Rolling 12-month average dose, as calculated using:

- Monthly calculations of ambient air radionuclide concentrations
- Monthly isotopic and field data from RAAMP sampler filter analyses

Decision Statement:

IF Emissions of Site-derived radionuclides are demonstrated to be significantly below the 0.1 millirem (mrem) per year action level prescribed for monitoring for 3 consecutive years—

THEN Radionuclide ambient air monitoring may be discontinued.

Note: This time frame was selected since continued recovery of vegetation on Site will further reduce dust emissions over time. Consequently, absent additional disturbances, highest emissions should occur immediately following completion of accelerated actions and before full vegetative recovery.

Reporting:

The results of the ambient radionuclide air monitoring will be reported annually to CDPHE and EPA in a manner consistent with other data reporting performed under RFCA, subject to the ambient air monitoring schedule.

4.3 Meteorological Monitoring

Continuous meteorological monitoring is conducted at the NREL M2 tower 1.2 miles north of the former Site meteorological tower location (note that CDPHE also continues to monitor meteorological parameters at several locations around the Site perimeter). Collected data comprise wind speed, wind direction, temperature, relative humidity (dew point), precipitation, and a calculated sigma-theta (used to determine Pasquill-Gifford stability classes). Data are used as inputs for air quality and emergency response dispersion modeling. Data are also used as inputs to CERCLA risk assessment calculations and hydrologic assessments.

4.3.1 Data Use for Modeling

Meteorological data are basic inputs into various regulatory and research models used at RFS. AQM uses screening and predictive models to assess emission impacts on the public and the environment. Exceedance of calculated thresholds may require implementation of pollution control measures or monitoring requirements. Modeling has also been performed to support the Actinide Migration Evaluation, with meteorological data feeding into both the erosion modeling and air dispersion/deposition modeling efforts. Real-time data are not used for these models; historical data and/or most-recent annual data are typically used, the choice depending on the specific question being investigated.

4.3.2 Meteorological Monitoring Specifications

The following data quality specifications are common to several data needs. Inputs to the meteorology decisions include:

Data and Frequencies:

- Wind speed, wind direction, temperature, and relative humidity;
- Rainfall data; and
- Atmospheric stability class calculations.

Boundaries:

Spatial:	Representative air flow patterns impacting RFS.
	A minimum of 10 meters (m) above ground level.
Temporal:	Continuous data, averaged every 15 minutes.
	Hourly averaged data, calculated from the 15-minute averages.
	Annually averaged data and frequency distributions.

Decision Statement:

IF	Regulatory compliance or risk assessment modeling is performed at RFS—
THEN	Standard, consistent, RFS-representative meteorological summaries shall be used to ensure the most representative model results.

Monitoring Requirements:

Use NREL meteorological monitoring resources to generate Site-representative meteorological data sets.

5.0 Ecological Monitoring

5.1 Introduction

This chapter describes the technical and regulatory basis for the approach to ecological monitoring at RFS. The Ecological Monitoring Program instituted at RFS has historically focused on characterizing ecological components in the Buffer Zone, and compliance with laws and regulations (e.g., the Endangered Species Act, the Migratory Bird Treaty Act [MBTA], wetlands regulations, weed control acts). The monitoring requirements presented here have been established through the DQO process, and represent a program that emphasizes natural resource conservation, habitat management, and regulatory compliance.

The program focuses on the collection of data necessary to ensure regulatory compliance, and to assess the effectiveness of DOE's natural resource conservation and habitat management efforts. These efforts are intended to comply with DOE's demonstrated desire to practice natural resource conservation (DOE 1994) and ecosystem management (Congressional Research Service 1994) on its properties.

These efforts also provide part of the basis for ongoing refinement of natural resource conservation and habitat management goals. Monitoring requirements that support ecological management decision making needed to achieve these goals are an essential component of the IMP. Monitoring requirements are divided into two categories: Regulatory Monitoring (monitoring with a regulatory driver) and BMPs (discretionary monitoring).

5.2 Natural Resource Conservation and Habitat Management Goals

Ecological conservation and management goals include the protection of currently viable ecosystems, unique and ecologically valuable natural resources, and special-concern species (threatened, endangered, candidate, proposed, state-listed, or other sensitive species), as well as compliance with wildlife and natural resource protection regulations. Early detection and management of problems or undesirable impacts to the RFS ecological resources before they become severe is extremely important.

Specific conservation and management goals for the major identified vegetation communities and one species of particular interest, the Preble's meadow jumping mouse (Preble's mouse), are presented in Table 5−1.

5.3 Descriptions of Vegetation Communities, Aquatic Ecosystems, and Preble's Mouse Populations

Vegetation communities at RFS provide specific habitats for associated wildlife, rare plants, and unusual plant associations. These communities include the xeric tallgrass prairie, mesic mixed grassland, high quality wetlands, tall upland shrubland, and the Great Plains riparian woodland complex. The aquatic ecosystem at RFS consists of ephemeral and intermittent streams, old stock ponds, and several water management impoundments. The Preble's mouse is of particular concern because it presently has a federally listed threatened species status, which provides special protection for the species under the Endangered Species Act.

Table 5–1. Conservation and Management Goals

Vegetation Community	Goal
Xeric Tallgrass Prairie	Maintain the current quantity (area) and quality of the vegetation community, and maintain the populations of bird and mammal species characteristic of xeric tallgrass prairie.
Tall Upland Shrubland	Maintain the quantity and quality of the vegetation community, maintain the populations of bird and mammal species characteristic of tall upland (seep) shrubland, and maintain population numbers and extent of Preble's mice within the habitat.
Great Plains Riparian Woodland Complex	Maintain the quantity and quality of the vegetation community, maintain populations of bird and mammal species characteristic of the riparian woodland complex, and maintain the population numbers and extent of Preble's mice within the habitat.
High Quality Wetlands	Maintain the quantity and quality of the vegetation community, and maintain the populations of bird and mammal species characteristic of the largest contiguous high quality wetlands (Rock Creek and Antelope Springs/Apple Orchard Springs Wetland complexes).
Mesic Mixed Grassland	Maintain the contiguous extent of mesic mixed grassland for heavily and frequently used wildlife areas, and maintain the populations of bird and mammal species characteristic of this vegetation community.
Revegetation Areas	Manage the revegetation areas for re-establishment of native plant and wildlife species.
Aquatic Community	Goal
Aquatic Community[a]	Maintain the quality of aquatic communities at RFS, including macro-invertebrate and vertebrate species characteristic of the community.
Species of Particular Interest	Goal
Preble's Mouse Populations	Maintain the quantity and quality of Preble's mouse habitat, and protect extant populations of the Preble's mouse.
Regulatory Compliance	Goal
Threatened and Endangered Species (T&E) and Species of Special Concern (SSC)	Protect T&E and SSC species at the Rocky Flats Environmental Technology Site (RFS), and comply with applicable state and federal T&E species protection regulations and policies.
T&E Species Habitat Mitigation	Re-establishment of Preble's habitat at project disturbances per requirements of U.S. Fish and Wildlife Service regulatory documents.
Migratory Birds	Protect migratory birds at RFS, and comply with applicable state and federal migratory bird protection requirements.
Wetlands	Protect RFS wetlands, and comply with applicable state and federal wetland protection requirements.
Wetland Mitigation	Re-establishment of wetlands (where required) at project disturbances per requirements of U.S. Environmental Protection Agency and U.S. Army Corps of Engineers regulatory documents.

[a]This goal is no longer governed by the IMP but represents an independent activity; therefore, no DQOs are presented for this activity.

5.3.1 Xeric Tallgrass Prairie

There are two types of xeric mixed grassland units at RFS, the xeric tallgrass prairie and the xeric needle-and-thread grass prairie. Identification of this vegetation community is based on the presence of big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), prairie dropseed (*Sporobolus heterolepis*), Indian-grass (*Sorghastrum nuntans*), and switchgrass (*Panicum virgatum*). These five species are considered to be tall grass prairie relicts. Of these species, only big bluestem and little bluestem are abundant at RFS. When the five species cover about 10 percent or more of a xeric mixed grassland community, the community is classified as xeric tallgrass prairie.

The soil in a xeric tallgrass prairie is visibly cobbly on the surface, and is considered to be a sandy clay loam. This vegetation community covers the high, rocky pediment on the western one-third of RFS. The xeric tallgrass prairie was selected for special conservation efforts due to its nationwide rarity.

The other type of xeric mixed grassland, the xeric needle-and-thread grass prairie, is also considered rare, but is not large enough to justify special management efforts at RFS. Xeric needle-and-thread grass prairie is differentiated from xeric tallgrass prairie by a greater cover of needle-and-thread grass (*Stipa comata*) and New Mexico feather grass (*Stipa neomexicana*) than of big bluestem and little bluestem or other tallgrass species.

The soils in which xeric needle-and-thread grass prairie are found are not as cobbly as those in the xeric tallgrass prairie, and have a higher visible component of caliche at the soil surface. This vegetation community occupies the tops of many of the eastern-most ridges of RFS.

5.3.2 Mesic Mixed Grassland

Mesic mixed grassland is characterized by western wheatgrass (*Agropyron smithii*) and blue grama grass (*Bouteloua gracilis*). Other common species include green needlegrass (*Stipa viridula*), Canada bluegrass (*Poa compressa*), and Kentucky bluegrass (*Poa pratensis*). The mesic grassland has a more solid turf appearance in contrast to the bunchgrass appearance of the xeric mixed grasslands. Surficial soils are clay loams that do not have the cobbly appearance typical of xeric mixed grassland soils. Most hillsides at RFS are considered mesic mixed grassland habitat.

The quality of these grasslands varies considerably across RFS. The mesic mixed grassland on the western side of RFS has been degraded by diffuse knapweed (*Centaurea diffusa*), although this problem has been greatly reduced through recent weed control efforts. Mesic mixed grassland on the eastern portion of RFS has been degraded by non-native species such as Japanese brome (*Bromus japonicus*), alyssum (*Alyssum minus*), and musk thistle (*Carduus nutans*). For classification purposes, a grassland is designated as mesic mixed grassland if western wheatgrass and blue grama grass form an understory beneath non-native species, regardless of dominance by non-native species.

Mesic mixed grasslands comprise one of the largest contiguous vegetation communities at RFS. In addition to its essential role as a foraging habitat, the size and isolation of the mesic mixed grassland often makes it very important to some wildlife species. A wide variety of grassland birds breed and forage in this habitat. Small mammals are abundant and diverse, and provide a suitable prey base for a variety of avian and mammalian predators. Many of the species supported by this vegetation community are rare or of special concern.

5.3.3 High Quality Wetlands

Numerous wetland areas exist at the Site. Some of the highest quality wetlands are those in the Rock Creek and Antelope Springs/Apple Orchard Springs Complexes. The Rock Creek wetlands are a large, seep-fed wetland complex extending about one mile from the foot of the easternmost seep-fed wetlands to the western-most short marsh areas. The Antelope Springs/Apple Orchard Wetland Complex encompasses the predominantly wet meadow, short marsh, and tall marsh habitat mosaic of upper Woman Creek Drainage Basin. These are also seep-fed wetlands that depend on ground water discharge for their continued existence.

Predominant vegetation in these wetlands includes cattails (*Typha sp.*) and bulrush (*Scirpus sp.*) in tall marsh community; Nebraska sedge (*Carex nebraskensis*) and Baltic rush (*Juncus balticus*) in short marsh habitat; and prairie cordgrass (*Spartina pectinata*), redtop (*Agrostis stolonifera*), showy milkweed (*Asclepias speciosa*), and Missouri iris (*Iris missouriensis*) in the wet meadow habitat.

These wetlands support a variety of terrestrial and aquatic organisms. Portions of these wetlands have been designated as prime Ute Ladies'-tresses (*Spiranthes diluvialis*) habitat (a federally listed threatened plant that may occur at RFS). Other portions support sensitive amphibian species and waterfowl. Many predatory mammals and bird species are dependent on these areas as hunting and foraging grounds due to their high prey species productivity.

5.3.4 Tall Upland Shrubland

The tall upland (seep) shrubland comprises stands of hawthorn (*Crataegus erythropoda*), chokecherry (*Prunus virginiana*), and occasionally wild plum (*Prunus americana*). Tall upland shrubland is found primarily on north-facing slopes above seeps, wetlands, and streams in the Rock Creek drainage in the northern portion of RFS, but small units occur across RFS. This vegetation community may be unique, because no similar units have been identified outside the general RFS vicinity. It is important habitat for the resident mule deer population. Mule deer are highly reliant on tall upland shrubland for fawning cover, winter thermal cover and browse, and summer shade and isolation cover. A number of rare bird species (e.g., bluegray gnatcatchers and chestnut-sided warblers) occupy this community as well. Some units of tall upland shrubland also provide habitat for the threatened Preble's mouse.

5.3.5 Great Plains Riparian Woodland Complex

Riparian areas are well known for the diversity of plant and animal species they support. The riparian woodland complex at RFS is a combination of two vegetation community classifications: riparian woodland and riparian shrubland, which form a complex mosaic habitat along the drainage bottoms on RFS. Due to its contiguous mixture of both trees and shrubs, the riparian areas are described as a complex. The woodland component of the complex is characterized by stands of plains cottonwood (*Populus deltoides*), peach leaf willow (*Salix amygdaloides*), Siberian elm (*Ulmus pumila*), and silver poplar (*Populus albus*). The shrubland component of the complex includes chokecherry (*Prunus virginiana*), snowberry (*Symphoricarpos occidentalis*), coyote willow (*Salix exigua*), leadplant (*Amorpha fruticosa*), and other shrubs.

The riparian woodland complex is an important habitat for a different songbird association than the grasslands, and shares some species with the tall upland shrubland. Several of the bird species using the riparian woodland complex as foraging and nesting cover are rare species (e.g., blue grosbeak). Like the tall upland shrubland community, this vegetation community is also seasonally important to the resident mule deer herd as shelter, forage source, and fawning grounds. Large cottonwood trees embedded within this unit provide nesting habitat for several raptor species, including great horned owls, red-tailed hawks, Swainson's hawks (a Colorado "at-risk" species), and American kestrels. The riparian woodland complex supports the greatest number of Preble's mice at RFS and is considered typical habitat for this species. The majority of monitoring, protection, and management of Preble's mouse habitat will occur in this community.

5.3.6 Aquatic Community

The aquatic ecosystem at RFS consists of a network of ephemeral and intermittent streams, and several scattered old stock ponds. In the Walnut Creek and Woman Creek drainages, there are several water management impoundments that retain large bodies of water. Numerous seep springs feed streams at RFS and provide limited wetland habitat. Other than the outflow of the seeps, and the water in the existing ponds and larger pools, very little permanent water exists at RFS.

During 1991−1992, the *Draft Phase III RFI/RI Report, Appendix E, Environmental Evaluation, Rocky Flats Plant 881 Hillside Area, Operable Unit 1* (DOE 1992b) and the *Baseline Biological Characterization of the Terrestrial and Aquatic Habitats at the Rocky Flats Plant* (DOE 1992c) studies conducted sampling to characterize the aquatic community at RFS. This effort included widespread benthic invertebrate sampling across RFS, and limited fish sampling in ponds and some streams. The Colorado Division of Wildlife (CDOW) listed five species of small fish native to the South Platte River drainage as State-endangered (the northern redbelly dace, southern redbelly dace, plains minnow, suckermouth minnow, and lake chub), and two as threatened (the brassy minnow and common shiner) (CDOW 1998).

In light of these potential listings, and the prior recommendation in the *1996 Annual Wildlife Survey Report* (Kaiser-Hill 1997a) that fish sampling be added to the Natural Resource Compliance and Protection Program's ecological monitoring effort, Kaiser-Hill authorized the addition of this study to the ecology program (Kaiser-Hill 1997b). This additional sampling initially focused on streams, and then sampled ponds on alternate years.

Fish sampling was discontinued by Kaiser-Hill in 2001. While fish sampling of the aquatic community attempted to quantify populations through relative abundance sampling, aquatic sampling in RFS's upper headwater streams did not provide sufficient numbers to estimate stream populations. Due to the ephemeral nature of these streams, the amount of viable habitat is extremely limited, and few fish have been captured except in ponds and pools.

An aquatic monitoring program in streams draining RFS was initiated in the summer of 2001 to characterize the existing aquatic communities (fish and macroinvertebrates) and physical habitat conditions in the Walnut, Woman, and Rock Creek drainages. The purpose of the monitoring program was to provide a baseline to determine the potential influences of Site closure activities and to serve as a reference for post-closure years. DOE has employed an aquatic contractor to perform this work. The contractor, whose work is independent of the IMP, will conduct aquatic sampling at RFS in accordance with protocols established by the BDCWA and various requesting agencies. These data will be collected, analyzed, and shared with various requesting agencies (see Aquatics Associates 2004, and Aquatics Associates 2005).

5.3.7 Preble's Mouse Habitat and Populations

The Preble's mouse (*Zapus hudsonius preblei*) is a species of particular concern at RFS because it is currently listed as threatened by the USFWS. This listing provides special protection for the species under the Endangered Species Act, and actions occurring in its habitat must be evaluated for potential impact to the mouse.

Preble's mice have been recorded in the major drainages of RFS: Rock Creek, Walnut Creek, Woman Creek, and the Smart Ditch drainages. Native plant communities in these areas provide a suitable habitat for this small mammal. Preble's mouse populations are found in association with the riparian zone and seep wetlands, and apparently prefer multi-strata vegetation with abundant herbaceous cover. The vegetation communities that provide Preble's mouse habitat include the Great Plains riparian woodland complex, tall upland shrubland, wetlands adjacent to these communities, and some of the upland grasslands surrounding these areas. Recent studies have produced a better understanding of population centers of the species, and studies over the past several years have also provided data to help estimate numbers of individuals within each population unit.

5.3.8 Revegetation

Revegetation and management of the areas disturbed at the Site during cleanup and closure activities will continue for several years. Areas were reseeded with native plant species to return the area to a more native state. The Rocky Flats, Colorado, Site Revegetation Plan (DOE 2005d) provides objectives, general assumptions, and principles; specification sheets for reseeding different locations at the Site; monitoring methodology; and decision making criteria for general revegetation projects at the Site. However, vegetation communities disturbed as a result of a RFCA activity that is subject to a RFCA decision document will incorporate revegetation criteria for the vegetation communities within the specific project decision document. Vegetation communities not associated with a RFCA decision document within Preble's mouse Protection Areas will be revegetated in accordance with agreements with the USFWS. Preble's mouse decisions are documented in the biological evaluations/opinions submitted to and issued by the USFWS. Wetland re-establishment decisions are documented in project specific wetland mitigation plans, permits from the U.S. Army Corps of Engineers (USACOE), or correspondence from the EPA, as appropriate. The Rocky Flats, Colorado, Site Wetland Mitigation Monitoring and Management Plan (DOE 2006f) provides guidance and direction for wetland monitoring and management activities.

5.3.9 Outside Factors Affecting RFS Ecology

The ecological resources at RFS are influenced not only by Site activities but also by activities that occur off Site. Outside factors that have potential to affect ecological resources at RFS include, but are not limited to, chronic wasting disease (CWD), West Nile virus, plague, and other zoonoses. These and other factors often affect wildlife regionally, and therefore must be considered when evaluating the ecology of the Site. Climate changes have the potential to affect the plant communities as do weed control efforts or the lack thereof, on lands surrounding RFS. Sociological and political factors have the potential to affect the ecology at RFS. For example, social or political pressures that restrict the use of grazing or prescribed fire on the grasslands will affect the long-term sustainability of the prairies at RFS.

5.4 Regulatory Compliance Monitoring DQOs

In addition to ecological conservation and habitat protection, specific decisions on threatened and endangered (T&E) species, state species of special concern (SSC), migratory birds, and wetlands must be considered. Two types of evaluations have been conducted. The first involves determining what potential impacts a project activity may have on T&E species, migratory birds, or wetlands, and whether mitigation actions may be required. Baseline data, previously collected at the Site, have been used for decision making. Project-specific decisions with regulatory implications have sometimes required the collection of additional data. The discussion that follows is applicable to each of the regulatory drivers. Note that specific data requirements and a design for sampling and analysis are not included in the discussion.

Specific management goals supported by these efforts are:

- Protect T&E and SSC species at RFS and comply with applicable state and federal T&E species protection regulations and policies;
- Protect migratory birds at RFS and comply with applicable state and federal migratory bird protection requirements; and
- Protect RFS wetlands and comply with applicable state and federal wetland protection requirements.
- The second type of evaluation involves monitoring that is required under some type of consultation document (e.g., a permit, biological opinion, decision document).

5.4.1 Threatened, Endangered, and Special-Concern Species

Data Types and Frequencies:

- Seasonal presence and absence, location, and abundance of T&E or SSC species in an area of potential impact by a proposed project;
- Seasonal timing of a proposed project;
- Presence of habitat considered suitable for T&E species;
- Biology of T&E or other species of concern (e.g., food habits, home range, habitat preference, nesting habits); and
- Information about the anticipated impacts of the proposed project.

Boundaries:

Spatial:	The area potentially affected by a project.
	Locations of alternative project sites.
	Jurisdictional policies and propriety.
Temporal:	The time frame in which a proposed project could occur.

Decision Statements:

IF	A T&E or SSC species, population, individual or habitat may be affected by a proposed project—
THEN	Notify project personnel and suggest alternatives for modifying the project.
IF	The project cannot be altered to achieve a “no effect” determination for the T&E species—
THEN	Advise DOE-RFPO to conduct a Section 7 consultation with USFWS.
IF	The determination is made to proceed with the proposed project by altering it—
THEN	Provide assistance with the design of the project for regulatory compliance requirements.
IF	Additional information is required to make a decision—
THEN	Develop project-specific sampling and analysis plans to provide the necessary information.

Note that additional required methods are not discussed here because the performance of biological assessments for T&E species is not within the scope of this plan.

5.4.2 Migratory Birds

Data Types and Frequencies:

- Seasonal presence, relative abundance, and location of migratory birds or their nests in areas potentially impacted by RFS projects;
- Location and seasonal timing of proposed projects that may affect migratory birds; and
- Biology of potentially affected migratory bird species (e.g., food and nesting habits, home range, habitat preference).

Boundaries:

Spatial: The area potentially affected by RFS projects.

Specific areas where migratory birds or nest locations overlap the footprint of specific proposed activities.

Locations of alternative project sites.

Jurisdictional policies and propriety.

Temporal: The time frame potentially affected by RFS projects.
Specific time frames where migratory birds, or nest locations, overlap the footprint of a specific proposed activity.

Decision Statements:

IF	Migratory birds, their nests, fledglings, or eggs are present in a location that may be affected by a proposed project—
THEN	Notify project personnel and determine whether the project can be altered to avoid impacts.
IF	Removal is required—
THEN	Comply with substantive requirements of the MBTA from the USFWS and adhere to permit limitations.
IF	Additional information is required to make a decision—
THEN	Develop project-specific sampling and analysis plans to provide the necessary information.

5.4.3 Wetlands

Data Types and Frequencies:

- Presence and location of wetlands on RFS (based on 1994 USACOE wetland report and field verification) (USACOE 1994);
- Presence and location of wetlands not mapped by the USACOE;
- Determination of jurisdictional wetlands presence based on USACOE wetland delineation manual (USACOE 1987);
- Location, timing, and description of proposed projects that potentially impact wetlands; and
- Jurisdictional policies and propriety.

Boundaries:

Spatial:	The area of a project.
	Areas where wetlands overlap the footprint of proposed activities.
	Locations of alternative project sites.
Temporal:	The time frame of a project.

Decision Statements:

IF	A wetland may be affected by a proposed project—
THEN	Advise project personnel and seek to redesign the project to avoid wetland impacts.
IF	The project cannot be redesigned to avoid impacts—
THEN	Proceed with a wetland delineation in accordance with USACOE wetland delineation guidelines (USACOE et al. 1987).
IF	The delineation indicates that the wetland is jurisdictional—
THEN	Advise DOE of the need to consult with USACOE and EPA to determine the need for and amount of mitigation wetland acreage that will be required for the project.

IF	Additional information is required to make a decision—
THEN	Develop project-specific sampling and analysis plans to provide the necessary information.

5.4.4 Preble's Mitigation Monitoring

Data Types and Frequencies:

- Baseline or reference area monitoring data;
- Annual monitoring data; and
- Success criteria from appropriate USFWS document

Boundaries:

Spatial:	Project footprints within Preble's habitat at RFS.
Temporal:	Post-project completion until concurrence received from USFWS that monitoring is no longer necessary.

Decision Statements:

IF	The revegetation does not meet the success criteria—
THEN	Determine whether management actions need to be taken at this time or whether additional time is required before success criteria are likely to be meet.

IF	The revegetation meets the success criteria—
THEN	Contact DOE to set up a meeting to discuss area for final concurrence from USFWS.

5.4.5 Wetland Mitigation Monitoring

Data Types and Frequencies:

- Baseline or reference area monitoring data;
- Annual monitoring data; and
- Success criteria (if appropriate) from EPA or USACOE document

Boundaries:

Spatial:	Wetland restoration areas at RFS.
Temporal:	Post-project completion until concurrence received from EPA or USACOE that monitoring is no longer necessary.

Decision Statements:

IF	The revegetation does not meet the success criteria—
THEN	Determine whether management actions need to be taken at this time or whether additional time is required before success criteria are likely to be meet.
IF	The revegetation meets the success criteria—
THEN	Contact DOE to set up a meeting to discuss area for final concurrence from EPA or USACOE.

5.5 Best Management Practice: Vegetation Community Monitoring DQOs

BMP monitoring is a discretionary natural resources management practice. DQOs have been developed for monitoring in five important vegetation communities. Monitoring the vegetation communities facilitates the management and conservation of vegetation communities, associated wildlife, rare plants, and unusual plant associations. The results of the monitoring can precipitate a reevaluation of management practices to better achieve specific vegetation community management goals.

Based on defined inputs and boundaries for each vegetation community, decision statements have been developed. The decision statements list monitored occurrences (e.g., a decline in native plant densities), and provide corrective actions for each problem.

5.5.1 Xeric Tallgrass Prairie Vegetation Community

Data Types and Frequencies:

- Existing area of xeric tallgrass prairie;
- Baseline estimates of plant, bird, and mammal species richness;
- Baseline estimates of bird and mammal presence or absence;
- Annual weed mapping and photo surveys, as applicable;
- Anticipated or estimated impact area of a proposed project;
- Identification of plant or wildlife species populations of interest; and
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial:	Current RFS geographic boundaries.
	Characteristic xeric tallgrass prairie within RFS.
Temporal:	Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occurs:

- A measured or anticipated loss of xeric tallgrass prairie from the baseline amount,
- New weed species are reported for the vegetation communities,
- Weed mapping or photo surveys indicate weed species are spreading or increasing in the community,
- Weed control assessment monitoring indicates low effectiveness of a treatment option, or
- Significant change in an assessment endpoint—

THEN Evaluate options to achieve the stated goals.

5.5.2 Tall Upland Shrubland Community

Data Types and Frequencies:

- Existing area of tall upland (seep) shrubland;
- Baseline estimates of plant, bird, and mammal species richness;
- Baseline estimates of bird and mammal presence or absence;
- Annual weed mapping and photo surveys, as applicable;
- Anticipated or estimated impact area of a proposed project;
- Identification of plant or wildlife species populations of interest; and
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial: Current RFS geographic boundaries.

Characteristic tall upland shrubland community within RFS.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occurs:

- A measured or anticipated loss of tall upland shrubland vegetation community from the baseline amount,
- New weed species are reported for the vegetation community,
- Weed mapping or photo surveys indicate weed species are spreading or increasing in the vegetation community,
- Weed control assessment monitoring indicates low effectiveness of a treatment option,
- Significant change in an assessment endpoint, or
- The area of known Preble's mouse habitat within the unit decreases substantially from baseline—

THEN Evaluate options to achieve the stated goals.

5.5.3 Great Plains Riparian Woodland Complex

Data Types and Frequencies

- Existing area of riparian woodland complex;
- Baseline estimates of plant, bird, and mammal species richness;
- Baseline estimates of bird and mammal presence or absence;
- Annual weed mapping and photo surveys, as applicable;
- Anticipated or estimated impact area of a proposed project;
- Identification of plant or wildlife species populations of interest; and
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial:	Current RFS geographic boundaries.
	Characteristic Great Plains riparian woodland complex community within RFS.
Temporal:	Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occurs:

- A measured or anticipated loss of riparian woodland complex vegetation community from the baseline amount,
- New weed species are reported for the vegetation community,
- Weed mapping or photo surveys indicate weed species are spreading or increasing in the vegetation community,
- Weed control assessment monitoring indicates low effectiveness of a treatment option, or
- Significant change in an assessment endpoint—

THEN Evaluate options to achieve the stated goals.

5.5.4 High Quality Wetlands

Data Types and Frequencies:

- Existing wetlands based on 1994 USACOE wetland map and study (restricted to Buffer Zone only);
- Baseline estimates of plant, bird, and mammal species richness;
- Baseline estimates of bird and mammal presence or absence;
- Annual weed mapping and photo surveys, as applicable;
- Anticipated or estimated impact area of a proposed project;
- Identification of plant or wildlife species populations of interest; and
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial: Rock Creek and Antelope Springs/Apple Orchard Springs wetland complexes.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occur:
- Existing high quality wetlands decrease visibly from baseline,
- A measured or anticipated loss of high quality wetlands from the baseline amount,
- New weed species are reported for the vegetation community,
- Weed mapping or photo surveys indicate weed species are spreading or increasing in the vegetation community,
- Weed control assessment monitoring indicates low effectiveness of a treatment option, or
- Significant change in an assessment endpoint—

THEN Evaluate actions to achieve the stated goals.

5.5.5 Mesic Mixed Grassland Vegetation Community

Data Types and Frequencies:

- Baseline map of mesic mixed grasslands;
- Baseline estimates of bird and mammal species richness;
- Baseline estimates of bird and mammal presence or absence;
- Annual weed mapping and photo surveys, as applicable;
- Anticipated or estimated impact area of a proposed project;
- Identification of plant or wildlife species populations of interest; and
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial: Current RFS geographic boundaries.

Characteristic mesic mixed grasslands within RFS and the Buffer Zone.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occur:
- A measured or anticipated loss of mesic mixed grassland vegetation community from the baseline amount,
- New weed species are reported for the vegetation community,
- Weed mapping or photo surveys indicate weed species are spreading or increasing in the vegetation community,

- Weed control assessment monitoring indicates low effectiveness of a treatment option,
- A decline in the bird or mammal species richness or densities,
- Loss or major decline of a predominant plant, bird, or mammal species from the vegetation community,
- Loss or major decline of a population of an identified plant species of interest, or plant or animal special-concern species, or
- Significant change in an assessment endpoint—

THEN Evaluate actions to achieve the stated goals.

5.5.6 Revegetation locations

Data Types and Frequencies:

- Locations of revegetation areas;
- Success criteria (defined in the Rocky Flats, Colorado, Site *Revegetation Plan*, DOE 2005); and
- Qualitative and quantitative monitoring data, as specified in the *Rocky Flats, Colorado, Site Revegetation Plan*.

Boundaries:

Spatial: Current RFS geographic boundaries.

Temporal: Yearly decisions from 2003 forward.

Decision Statement:

IF One or more of the following occur:

- Measured quantitative variables do not meet success criteria,
- Qualitative observations indicate low success of revegetation efforts,
- New weed species are reported for the revegetation locations,
- Weed mapping or photo surveys indicate weed species are spreading or increasing in the revegetation areas,
- Weed control assessment monitoring indicates low effectiveness of a treatment option,
- Seeded species are not establishing,
- A decline in the bird or mammal species richness or densities,
- Loss or major decline of a predominant plant, bird, or mammal species from the vegetation community, or
- Loss or major decline of a population of an identified plant species of interest, or plant or animal special-concern species—

THEN Evaluate actions to achieve the stated goals.

5.6 Design for Integrated Ecological Monitoring

An Ecological Monitoring Program is necessary to provide data for regulatory compliance and natural resource conservation and habitat management at the RFS. In addition to data required for conservation and management decisions, RFS must remain in compliance with applicable wildlife and wetland protective regulations. To meet this need, the proposed Ecological Monitoring Program will conduct monitoring to achieve the desired management goals and provide the information necessary to properly manage the natural resources. The data collected will be used to make discrete, but ongoing, determinations regarding changes in those key variables. These determinations will drive decisions regarding ecological protection and compliance decisions.

5.6.1 Decision Errors

Limits on decision errors were stated by the planning team as follows:

- Reasonable expectation that monitoring will detect a change of interest listed above;
- Reasonable expectation that monitoring will not incorrectly indicate that one or more changes occurred, triggering an unnecessary evaluation of management actions;
- Reasonable expectation that monitoring will detect the presence of special-concern species and impacts to such species; and
- Reasonable expectation that compliance with applicable regulations can be achieved.

The decision will be based on a qualitative study of the area of potential impact on special-concern species, as well as existing information about the potentially impacted area or similar habitat that will be affected. It should be noted that an impact to an individual, or population, is of concern. Care will be taken to identify potential impacts to T&E species.

Decisions will be based on a qualitative study of the area of potential impact for migratory birds as well as existing information on the potentially impacted habitat. Care will be taken to identify and avoid potential impacts to migratory bird species.

Decisions will be based on qualitative evaluation of the area of potential impact for wetlands and jurisdictional determination of wetlands present. Wetland determination will be governed by performance of a wetland delineation, in accordance with the USACOE wetland delineation manual (USACOE 1987). Care will be taken to identify, and avoid, potential impacts to wetlands. Wetland investigations will be conducted to err on the side of protection.

Decision errors and their consequences are presented in Table 5−2.

Table 5–2. Decision Errors and Their Consequences

Decision Error	Consequences
Fail to detect one or more changes of interest that would lead to an evaluation of management actions. (This error type is of greater concern.)	Vegetation or aquatic community management approaches (e.g., weed management, limited access, limitation of disturbances) go unchanged, with the possible loss of habitat (or species) that could otherwise be conserved or protected.
Incorrectly decide one or more changes occurred, triggering an unnecessary evaluation of management actions.	Unnecessary expenditure of time and money to reevaluate vegetation community management plans that are actually working.

5.6.2 Monitoring Design

Table 5−3 outlines the required regulatory monitoring that will be conducted during 2006 and is required post-closure until the appropriate concurrence is received from the oversight agency. Table 5−4 outlines the selected BMP monitoring that may be conducted during 2006 and discretionary post-closure monitoring. It should be noted with respect to the BMP monitoring for 2006 and beyond, this list includes suggestions for the type of monitoring that may be performed. These BMP activities are discretionary in nature and may be conducted as needed. Additional monitoring not listed may be incorporated to provide information as necessary.

The methods used to conduct the regulatory compliance and BMP monitoring are outlined in the *Ecology Monitoring Methods Handbook* (Kaiser-Hill 2005d). It contains the methods and location information where specific monitoring activities are conducted.

End of current text

Table 5–3. Best Management Practice (BMP) Ongoing and Recommended Ecological Monitoring

Project	Planned Activity					2006[a]	Future[b]	Methods[c]	Success Criteria
	Transects /Plots	Qualitative Assessments	Photo Monitoring	Weed Evaluations/ Control	Mapping				
Wildlife Monitoring									
Frog Vocalization Survey	--	Apr	--	--	--	2006	TBD	10	NA
Bird Circle Plots	Jun	--	--	--	--	--	TBD	11	--
Small Mammal Trapping	Late Spring/ Early Fall	--	--	--	--	--	TBD	12	--
Preble's Mouse Trapping/Telemetry	May/Jun/ Sep	--	--	--	--	--	TBD[d]	13, 14, 15	--
Prairie Dog Monitoring	--	--	--	--	Summer	--	TBD	16	--
Deer Count	--	Dec/Jan	--	--	--	--	TBD	17	--
Vegetation Surveys									
Biocontrol Monitoring	Jul/Sep	--	Jul	--	--	--	TBD	NA	NA
Dalmatian Toadflax Monitoring	Jun	--	Jun	--	--	2006	TBD	8	NA
Weed Mapping	--	--	--	--	When plants flowering	2006	2007+	2	NA
Rare Plant Monitoring	--	May/June/Oct	--	--	--	2006	2007+	3	NA
High Value Vegetation Photopoints	--	--	Sep	--	--	2006	2007+	4	NA
Industrial Area Photopoints	--	--	May/Jun/Sep	--	--	2006	2007+	4	NA
Revegetation Monitoring									
Qualitative Monitoring	--	Jul/Aug	Jul/Aug	During growing season	--	2006	2007+	1, 4	--
Quantitative Monitoring	Jul/Aug	Aug	May/Aug	During growing season	--	2006	2007+	1, 4, 6, 7	Revegetation Plan Criteria: 1. A minimum of 30 percent relative foliar cover of live desired species (seeded native species and/or non-seeded native species). 2. A minimum of 70 percent total ground cover comprised of litter cover, current year live vegetation basal cover, and rock cover. 3. A minimum of 50 percent of the seeded native species will be present at the revegetation site. 4. No single species will contribute >45 percent of the relative foliar cover (except in areas where dominance by a single species is appropriate for long term wildlife and habitat management objectives). Noxious weeds: Noxious weeds will be evaluated on a species specific basis and weed control will be employed as necessary using appropriate Integrated Weed Management Plan strategies to achieve the success criteria listed above. Reseeding: Bare areas >500 square feet exist over the course of a single growing season; or, Vegetative cover <75 percent of success criteria over four growing seasons.

Note: The timeframes listed for the various activities are suggestions only.
[a]These activities planned for 2006.
[b]The BMP activities listed for the future (2007+/TBD) are suggested only. These are voluntary activities that may or may not be conducted depending on the information needs for future management.
[c]The number in the methods column refers to the chapter or section number in the *Ecology Monitoring Methods Handbook* (Kaiser-Hill 2005d).
[d]Future status of Preble's mouse monitoring will be determined by progress toward delisting of the mouse.
Notes:
NA = Not applicable
TBD = To be determined

Table 5–4. Regulatory Ongoing and Post-Closure Ecological Monitoring

Project	Oversight Agency	Planned Activity						Report[b]	Success Criteria	Decision Document (Driver)	Methods[c]
		Transects/ Plots[a]	Qualitative Assessments	Photo Monitoring	Shrub Counts	Weed Evaluations/ Control	Mapping				
Compliance Monitoring											
Preble's Mouse Mitigation Monitoring											
Flume Project	USFWS	Jul/Aug	Jul/Aug	Jul/Aug	Jul/Aug	During growing season	--	Annual Flume Project Report to USFWS (due 12/01 annually)	Flume Project Success Criteria: 1. Herbaceous cover = 80 percent of pre-disturbance cover 2. Shrub/Tree Survival = 80 percent survival of planted materials 3. Noxious weed cover <5 percent foliar cover in revegetation area	Water Measurement Flume Replacement Project RFS BA and USFWS BO	1, 4, 19
Incinerator		Jul/Aug	Jul/Aug	Jul/Aug	--		--	Annual Incinerator Project Report to USFWS (due 12/01 annually)	PBA Success Criteria: 1. Grass, forb, shrub cover = 80 percent of reference area 2. 50 percent of seeded species present in revegetation area 3. Relative native cover = 50 percent of reference area 4. Woody stem density = 50 percent of reference area (riparian areas only) 5. Horizontal herbaceous density = 50 percent of reference area (riparian areas only) 6. Noxious weed cover <5 percent foliar cover in revegetation area	Buffer Zone Concrete Removal Project BE and Concurrence letter from USFWS. PBA Part I and BO.	1, 4, 6, 7
Original Process Waste Lines Disturbance		--	Jul/Aug	Jul/Aug	--		--		See Incinerator Project	USFWS PBA Part II and BO	1, 4
C-1 Pond Dam Notch Project		Jul/Aug	Jul/Aug	Jul/Aug	--		--				1, 4, 6, 7, 9
East Shooting Range Project	USFWS	--	Jul/Aug	Jul/Aug	Jul/Aug	During growing season	--	East Shooting Range Report (due 12/01 annually)	See Incinerator Project	East Shooting Range Remediation Project BA and BO	See PBA, Part II
PBA Part II Projects		--	Jul/Aug	Jul/Aug	Jul/Aug		--	Annual PBA Part II Projects Report to USFWS (due 12/01 annually)		USFWS PBA Part II and BO	
Phytoremediation Project		--	Jul/Aug		Jul/Aug		--	Phytoremediation Report (due 12/01 annually)		Phytoremediation BA and BO	

Table 5−4 (continued). Regulatory Ongoing and Post-Closure Ecological Monitoring

Project	Oversight Agency	Planned Activity						Report[b]	Success Criteria	Decision Driver (Document)	Methods[c]
		Transects/ Plots[a]	Qualitative Assessments	Photo Monitoring	Shrub Counts	Weed Evaluations/ Control	Mapping				
Preble's Mouse IA Mitigation Credit Areas	USFWS	Jul/Aug	Jul/Aug	Jul/Aug	--	During growing season	--	Annual PBA Part II Projects Report to USFWS (due 12/01 annually)	See Incinerator Project		See PBA, Part II
Erosion Control Inspections PBA Part II activities		--	Weekly	--	--		--				
Wetland Mitigation Monitoring											
903 Pad Lip Area Wetlands	EPA	Jul/Aug	Jul/Aug	Jul/Aug	--	During growing season	Jul/Aug	Annual Report to EPA on Wetland Monitoring (due 1/31/06)	See Rocky Flats, Colorado, Site Wetland Mitigation Monitoring and Management Plan	EPA Letter	See Rocky Flats, Colorado, Site Wetland Mitigation Monitoring and Management Plan
B-Pond Sediment Remediation Project		Jul/Aug	Jul/Aug	Jul/Aug	--		Jul/Aug	Annual Wetland Monitoring Report to EPA (due 3/1 annually)[d]		[e]Rocky Flats, Colorado, Site Wetland Mitigation Monitoring and Management Plan	
East Shooting Range Project		--	Jul/Aug	Jul/Aug	--		--				
Original Landfill Project	EPA	--	Jul/Aug	Jul/Aug	--	During growing season	Jul/Aug	Annual Wetland Monitoring Report to EPA (due 3/1 annually)	See Rocky Flats, Colorado, Site Wetland Mitigation Monitoring and Management Plan	Rocky Flats, Colorado, Site Wetland Mitigation Monitoring and Management Plan	See Rocky Flats, Colorado, Site Wetland Mitigation Monitoring and Management Plan
Present Landfill Pond		Jul/Aug	Jul/Aug	Jul/Aug	--		Jul/Aug				
C-1 Pond Dam Notch Project	USACOE	Jul/Aug	Jul/Aug	Jul/Aug	--		Jul/Aug				
IA Land Configuration Project		Jul/Aug	Jul/Aug	Jul/Aug	--		Jul/Aug				

[a]The use of transects or plots for quantitative monitoring is dependent on the amount of vegetation growing in the wetland areas. If little has come up, qualitative assessments will be used instead of quantitative.
[b]Reporting requirements: Reporting for Preble's mouse mitigation monitoring is generally required for a minimum of 3 years. If success criteria are not met or the USFWS does not concur that success has been achieved, monitoring and reporting continues until the USFWS no longer requires it. For wetland issues, the monitoring and reporting continue for a minimum of 3 years or until the EPA or USACOE concurs that the wetlands are self-sustaining and viable.
[c]The number in the methods column refers to the chapter or section number in the *Ecology Monitoring Methods Handbook* (Kaiser-Hill 2005d).

Notes:
BA = Biological Assessment
BE = Biological Evaluation
BO = Biological Opinion
EPA = U.S. Environmental Protection Agency
IA = Industrial Area
PBA = Programmatic Biological Assessment
USACOE = U.S. Army Corps of Engineers
USFWS = U.S. Fish and Wildlife Service

6.0 Soil Monitoring

Routine RFS-wide soil monitoring has been conducted for many years, with sampling performed by both CDPHE and RFS personnel. Data have been collected to determine whether RFCA accelerated actions were required or to confirm that RFCA accelerated actions were complete. Recent soil sampling has been focused on specific areas of the site needing characterization for the Site-wide Remedial Investigation/Feasibility Study (RI/FS) effort to support the comprehensive risk assessment (CRA). More than 1 million records of soil data are being used to complete the RI/FS. This section describes the sampling process that is currently implemented in the fourth quarter of FY 2005.

6.1 Soil Characterization

Prior to FY00, soil characterization was completed in accordance with approved SAPs for a specific IHSS or group of IHSSs within relatively close geographic proximity. To streamline the regulatory review process, existing IA and Buffer Zone characterization data were summarized (DOE 2000 and DOE 2001b), and two SAPs were developed to direct the soil characterization activities: the *Industrial Area Sampling and Analysis Plan* (IASAP) (DOE 2001c) and the *Buffer Zone Sampling and Analysis Plan* (BZSAP) (DOE 2002). These SAPs emphasize performing real-time analyses using an on-Site laboratory and field portable instruments to streamline the sampling and data analysis processes and shorten the time to render remedial decisions. The specific sampling and analytical requirements for each IHSS group were contained in SAP Addenda, which were prepared and submitted for review and agreement to the Lead Regulatory Agency (LRA) for the particular IHSS Group. The Addenda provided “starting points” from which the soil cleanup activities have been planned. In-process and final “end point” confirmation sampling and analysis are guided by the strategies and decision rules defined in the SAPs. In 2004, the IASAP and BZSAP were combined into one Site-wide SAP titled *IABZ Sampling and Analysis Plan* (DOE 2004d).

It should be noted that some of the soil sampling locations no longer exist as they were at the time of sampling (for example, areas that have been remediated). Samples determined to be no longer representative (NLR) have been removed from ongoing and future evaluation processes.

As of August 31, 2005, 95 percent of the 360 IHSSs, underbuilding contamination areas (UBCs), and potential areas of concern (PACs) have been dispositioned with the regulators through accelerated actions or justification for no further accelerated action. No accelerated actions remain and DOE’s focus is now toward the RI/FS, including the CRA. The RI process has identified the need for additional soil data to fill gaps in our understanding of the Site.

6.2 Ad Hoc Sediment Sampling

Sediment sampling for the purpose of understanding observed impacts to surface water may be employed to investigate potential contributions from various potential source areas within the targeted subdrainage. The analytes and locations will be selected based on surface water observations. Soil and sediment samples are managed under Procedure 4-F99-ENV-OPS-FO.23, *Management of Soil and Sediment Investigative Derived Materials*. The data are summarized in Section 5.0 of the RI/FS, “Nature and Extent of Surface Water and Sediment Contamination.”

End of current text

7.0 Interactions Between Media

7.1 Overview

Some monitoring is used to characterize interactions between or among the various environmental media. Possible interactions are presented in Table 7−1, which represents a conceptual model of integrated monitoring at RFS. Soil and water interactions have been modeled for integrated flow and VOC transport. Potentially significant interactions that require decision making and data are presented below.

Table 7–1. Interactions Between Media, Significance at RFS, and Monitoring to Evaluate Interactions

Interactions Between Media	Significance at RFS	Monitoring to Evaluate Interactions
Surface Water to Ecology	Potentially significant. Surface water flow and contamination could impact local ecology. However, the local ecology has remained healthy during a variety of climatic and flow conditions. Published RFS research indicates that this is not a major pathway for actinides.	Data from RFS-wide surface water monitoring may be used to assess potential ecological impacts. The ecological monitoring program is also designed to detect ecological changes and assess general ecological health. Project-specific evaluations have been conducted to assess potential impacts.
Surface Water to Ground Water	Potentially significant. Contaminants that are typically insoluble (such as Pu and Am) are not prone to move from surface water to ground water. However, more soluble contaminants (such as U) are transported from surface water to ground water.	Collocated surface water and ground water data can be analyzed to assess where and for what constituents the surface water to ground water pathway is significant.
Surface Water to Air	Not significant. Surface water quality will not significantly impact air quality (i.e., cause exceedances of air quality standards).	Significant impacts on air would be detected by monitoring.
Surface Water to Soil	Potentially significant. Water in drainages and ponds will not significantly increase contaminant concentrations in soil; however, runoff could spread contaminants on surface soils and increase sediment concentrations.	Soil characterization has been conducted before, during, and after accelerated action projects. Results of the Actinide Migration Evaluation have not indicated any need for continuing, long-term soil investigation but stabilization is needed to diminish runoff.
Ground Water to Surface Water	Potentially significant. Some RFS ground water flows into RFS surface water drainages; however, the majority is lost to evapotranspiration.	Surface water monitoring may detect impacts from a limited suite of ground water contaminants. Data from ground water monitoring are also used to assess and predict potential surface water impacts.
Ground Water to Ecology	Potentially significant. Contaminated ground water could indirectly impact ecological resources.	Data from RFS-wide ground water monitoring may be used to assess and predict potential ecological impacts. The ecological monitoring program is also designed to detect ecological changes.
Ground Water to Air	Not significant. Ground water will not significantly affect air quality.	Ground water monitoring would detect ground water contamination that could impact surface water quality. Volatilization of surface water contaminants is unlikely to have significant air quality impacts but can be estimated if needed.
Ground Water to Soil	Not significant. Ground water contaminants appear in surface water but are not likely to contaminate unsaturated soils.	Results of the Actinide Migration Evaluation have not indicated any need for continuing, long-term soil investigation.

Table 7−1 (continued). Interactions Between Media, Significance at RFS, and Monitoring to Evaluate Interactions

Interactions Between Media	Significance at RFS	Monitoring to Evaluate Interactions
Air to Soil	Potentially significant. Fugitive emission sources could deposit contaminants on soil.	Soil monitoring has been conducted to determine the impacts of air emissions to soil. Also, potential impacts can be extrapolated from air monitoring data. Results of the Actinide Migration Evaluation have not indicated any need for continuing, long-term soil investigation.
Air to Ecology	Potentially significant. Fugitive emission sources could deposit contaminants on ecological resources.	The ecological monitoring program is designed to detect ecological changes. Air monitoring would detect degraded air quality that could impact other media.
Air to Surface Water	Potentially significant. Fugitive emission sources could degrade surface water quality.	Surface water monitoring would detect significant increases in contaminant concentrations. Air monitoring would detect degraded air quality that could impact other media.
Interactions Between Media	Significance at RFS	Monitoring to Evaluate Interactions
Air to Ground Water	Not significant. Contaminants in air will not directly impact ground water quality.	Ground water monitoring will track ground water contamination, and air monitoring would detect degraded air quality that could impact other media.
Soil to Surface Water	Significant. Contaminants in surface soils are transported to surface water via runoff and surface water quality is degraded.	Surface water monitoring would detect increases in contaminant concentrations.
Soil to Ecology	Could be significant. Contaminated soils could adversely impact local ecology.	The ecological monitoring program is designed to detect ecological changes.
Soil to Air	Significant. Contaminants in surface soil are resuspended and air quality is affected.	Significant impacts on air quality would be detected by air monitoring.
Soil to Ground Water	Significant. Contaminants may migrate from surface and subsurface soils to ground water via percolation.	The ground water well network is designed to detect increases in contaminant concentrations in ground water.

Notes:
Am = Americium
Pu = Plutonium
RFS = Rocky Flats Environmental Technology Site
U = Uranium

7.2 Water and Ecological Health

As indicated in Table 7−1, there are interactions between surface water, ground water, and plants and animals at RFS. Changes in water flow into and out of RFS could impact significant habitat and species of concern located both on Site and downstream from RFS (e.g., the Preble's mouse at RFS and whooping cranes in Nebraska). For example, aggregate-mining activities at the west end of RFS may alter surface water flowing onto RFS. Similarly, modeling has shown that removal of buildings and reconfiguration of the IA will reduce water flow off the IA into Walnut Creek by as much as 80 percent. Water is one of the key abiotic components impacting some of the significant habitats.

Site-specific relationships between water availability and ecological health, and ground water and surface water interactions, were not previously well understood. One of the primary goals of the Site-Wide Water Balance activity was to improve the understanding of interactions. The Site-

Wide Water Balance developed a hydrologic design basis for RFS closure activities. The Site-Wide Water Balance provides RFS with a management tool that includes, but is not limited to, the following objectives:

1) Evaluate how water hydrology is likely to change from present to final configuration;
2) Predict surface water impacts from ground water for present and final configuration;
3) Provide data to support decisions for final IA configuration to protect surface water quality (cover design and land recontouring);
4) Provide information for the CRA and the Final CAD/ROD; and
5) Provide information on locations of water retention or loss in the drainages that could be used for wetland analysis.

The Site-Wide Water Balance is being updated in the last quarter of FY 2005 based on the latest land reconfiguration.

End of current text

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Appendix A

Surface Water

A.1. NPDES Application Testing Requirements

The RFS NPDES permit for discharge from the Site's wastewater treatment plant and storm water outfalls will expire September 30, 2005, and will not be renewed. The wastewater treatment plant was demolished in December 2004, and Site drainages were reconfigured to reduce the number of storm water outfalls. Storm water will continue to be monitored in accordance with the IMP, as specified in the permit.

A.2. RFCA Analytes of Interest for POEs and POCs

The AoIs for POEs listed in Table A−1 are those analytes agreed upon with the stakeholders and the regulators during the development of the original IMP. These analytes are monitored for at POE locations GS10, SW093, and SW027, and they are the analytes for which monitoring funds have been requested. Attachment 5, Table 1 of RFCA specifies additional analytes beyond those specified here, and all of the contaminant limitations listed are applicable. Most of those contaminant limitations are not measured above the standards or action levels and pose hypothetical health risks well below a 10^{-6} criterion. These are not a threat to the environment and are not included in routine monitoring.

The AoIs for POCs listed in Table A−2 are those analytes agreed upon with the stakeholders and the regulators during the development of the original IMP. These analytes are monitored for at POC locations GS01, GS03, GS08, GS11, and GS31, and are the analytes for which monitoring funds have been requested. Attachment 5, Table 1 of RFCA specifies additional analytes beyond those specified here, and all of the contaminant limitations listed are applicable. Most of those contaminant limitations are not measured above the standards or action levels and pose hypothetical health risks well below a 10^{-6} criterion. These are not a threat to the environment and are not included in routine monitoring. Refer to Table A−2 for specific analytes at specific locations.

AoIs for POEs and POCs were developed and agreement achieved on the basis of the following assumptions. These assumptions allowed all Parties to agree that funding and resources should be focused on a relatively short list of contaminants for which there is reasonable cause to expect measurements above the RFCA standards and actions levels.

- Discharges from terminal ponds will be from batch operations as currently conducted.
- Sampling for RFCA compliance at POEs and POCs will be flow-proportional.
- Predischarge sampling by CDPHE will be comprehensive.
- Cost-effective analytical methods used to monitor the AoIs may also yield information about other potential, but unanticipated, contaminants.
- Any of the Parties may, from time to time, identify additional AoIs for cause, for a specific discharge event. If the Parties agree, additional contaminants may be added to the ongoing AoIs specified here.

Table A−1. POE Analytes of Interest

Parameter	Rationale for Inclusion as Analyte of Interest
Plutonium-239/240	High level of public concern. Known carcinogen. Known past releases with measurements above *Rocky Flats Cleanup Agreement* (RFCA) stream standards and action levels provides reasonable cause to monitor for future releases that may be above RFCA action levels.
Uranium-233/234, -235, and -238	Known renal toxicity; present on Site. Known past releases with measurements above RFCA stream standards and action levels provides reasonable cause to monitor for future releases that may be above RFCA action levels.
Americium-241	Known carcinogen; present on Site. Known past releases with measurements above RFCA stream standards and action levels provides reasonable cause to monitor for future releases that may be above RFCA action levels.
Beryllium, total	Known to cause berylliosis in susceptible individuals when exposed by inhalation. May also cause contact dermatitis. Present on Site. Will be monitored as an indicator of releases from process and waste storage areas.
Chromium, total	Physiological and dermal toxicity. High level of regulatory concern, due in part to a 1989 chromic acid incident. Low levels can cause significant ecological damage.
Silver, dissolved	Highly toxic to fish at low levels. Used on Site only for photographic development, which has since been discontinued. Routinely accepted by publicly owned treatment works as municipal waste, but discharge is regulated. May be removed from list later if data do not support concern.
Cadmium, dissolved	Highly toxic to fish at low levels with chronic exposure. Known human carcinogen and depletes physiologic calcium. Formerly used on Site in electroplating operations.
Hardness	Required to evaluate dissolved metals analyses due to its effect on metal solubility.
Flow	Required to detect flow events (precipitation, spills, discharges), evaluate contaminant loads, and plan pond operations and discharges. Affects most decision rules and is the most commonly discussed attribute of Site surface waters.
Other notes:	Volatile organic compounds (VOC), iron, and manganese are specifically excluded from the list. The Parties recognize that VOCs will not be effectively monitored at these locations, and defer to the decision rules that drive monitoring closer to the sources of VOC contamination.

Table A−2. POC Analytes of Interest

Parameter	Rationale for Inclusion as Analyte of Interest
Plutonium-239/240	High level of public concern. Known carcinogen. Known past releases with measurements above the *Rocky Flats Cleanup Agreement* (RFCA) stream standards and action levels upstream of the terminal ponds provides reasonable cause to monitor for future releases that may be above RFCA action levels.
Uranium-233/234, -235, and –238	Known renal toxicity; present on Site. Known past releases with measurements above the RFCA stream standards and action levels provides reasonable cause to monitor for future releases that may be above RFCA action levels.
Americium-241	Known carcinogen; present on Site. Known past releases with measurements above the RFCA stream standards and action levels provides reasonable cause to monitor for future releases that may be above RFCA action levels.
Flow	Required to detect flow events (precipitation, spills, discharges), evaluate contaminant loads, and plan pond operations and discharges. Affects most decision rules and is the most commonly discussed attribute of Site surface waters.
Other notes:	Non-POC monitoring specified in Table 2−24 is not reflected in this table, as the Parties did not intend Indiana Street be a POC for the parameters listed in that table.

Appendix B

Ground Water

Table B−1. Proposed Monitoring Locations

Location	Frequency	Class	Plume or Area	Formation	Purpose
00191	Every other year	Evaluation	903 Pad	AL	Monitor eastward flow of 903 Pad Plume
00193	Semiannual	AOC	Woman Creek Drainage	BD	Monitor ground water in Woman Creek drainage downgradient of ground water plumes
00203	Every other year	Evaluation	Solar Ponds	AL	Monitor southeast flow from 700 Area and SEPs
0487	Quarterly	Decision Document	OU1	AL	Monitor downgradient OU1 Plume in accordance with OU1 CAD/ROD
00491	Every other year	Evaluation	903 Pad/Ryan's Pit	BD	Monitor Ryan's Pit/903 Pad Plume
00797	Semiannual	Sentinel	881 Hillside	AL	Monitor flowpath from B881 to Woman Creek
00897	Every other year	Evaluation	Mound	BD	Monitor Mound Plume source area
00997	Semiannual	AOC	South Walnut Creek Drainage	AL	Monitor South Walnut Creek drainage at Pond B-5
1786	Semiannual	Decision Document	Solar Ponds Plume	AL	Monitor downgradient of SPPTS in accordance with associated Decision Document
3586	Semiannual	Decision Document	South Walnut Creek	AL	Monitor downgradient of MSPTS in accordance with associated Decision Document
3687	Every other year	Evaluation	East Trenches	BD	Monitor East Trenches Plume source area
03991	Every other year	Evaluation	East Trenches	AL	Monitor east component of East Trenches Plume toward South Walnut Creek
4087	Semiannual	Sentinel	Present Landfill	AL	Monitor downgradient Present Landfill/East Landfill Pond ground water quality
04091	Semiannual	Sentinel	East Trenches	AL	Monitor east component of East Trenches Plume toward South Walnut Creek
4787	Semiannual	Decision Document	OU1	AL	Monitor downgradient OU1 Plume in accordance with OU1 CAD/ROD
4887	Semiannual	Decision Document	OU1	AL	Monitor downgradient OU1 Plume in accordance with OU1 CAD/ROD

Table B−1 (continued). Proposed Monitoring Locations

Location	Frequency	Class	Plume or Area	Formation	Purpose
88205	Every other year	Evaluation	B881	AL/BD	Monitor flow from B881, 800 Area toward Woman Creek
05691	Every other year	Evaluation	East Trenches	AL	Monitor East Trenches Plume source area
07391	Every other year	Evaluation	903 Pad/Ryan’s Pit	AL/BD	Monitor Ryan's Pit source area
10304	Semiannual	AOC	Woman Creek Drainage	AL/BD	Monitor flowpath of Ryan's Pit/903 Pad Plume toward Woman Creek
10394	Annual	Boundary	Woman Creek at Indiana Street	AL	Monitor ground water in Woman Creek drainage at Indiana Street
10594	Semiannual	AOC	North Walnut Creek Drainage	AL/BD	Monitor North Walnut Creek drainage below Pond A-1
10992	Semiannual	Decision Document	OU1	AL	Monitor downgradient OU1 Plume in accordance with OU1 CAD/ROD
11092	Semiannual	Decision Document	OU1	AL	Monitor downgradient OU1 Plume in accordance with OU1 CAD/ROD
11104	Semiannual	AOC	Woman Creek Drainage	AL/BD	Monitor Woman Creek drainage downgradient of South IA Plume and Original Landfill
11502	Semiannual	Sentinel	South IA	BD	Monitor South IA Plume and B444 flow toward Woman Creek
15699	Semiannual	Sentinel	Mound	AL/BD	Monitor downgradient MSPTS ground water quality
18199	Every other year	Evaluation	IHSS 118.1/B771	AL/BD	Monitor IHSS 118.1 source area removal
20205	Semiannual	Sentinel	B771/774	AL	Monitor downgradient of 700 Area, IHSS 118.1
20505	Semiannual	Sentinel	B771/774	AL	Monitor downgradient of 700 Area, IHSS 118.1
20705	Semiannual	Sentinel	700 Area	AL	Monitor downgradient of 700 Area and IHSS 118.1
20902	Every other year	Evaluation	700 Area	BD	Monitor downgradient of IHSS 118.1 and 700 Area
21505	Every other year	Evaluation	North IA	AL	Monitor downgradient of 700 Area
22205	Every other year	Evaluation	North IA	AL	Monitor downgradient (north) tip of SEP VOC plume toward North Walnut Creek

Table B−1 (continued). Proposed Monitoring Locations

Location	Frequency	Class	Plume or Area	Formation	Purpose
22996	Every other year	Evaluation	B886	AL	Monitor ground water flowing east from 800 Area
23296	Semiannual	Sentinel	South Walnut Creek	AL	Monitor ground water downgradient of ETPTS
30002	Semiannual	Sentinel	North Walnut Creek	BD	Monitor ground water in North Walnut Creek drainage below PU&D Yard Plume
30900	Every other year	Evaluation	PU&D	AL	Monitor PU&D Yard Plume source area
33502	Every other year	Evaluation	Oil Burn Pit #1	AL	Monitor VOC Plume source area in buried drainage south of B371
33604	Every other year	Evaluation	Oil Burn Pit #1	AL/BD	Monitor VOC Plume source area in buried drainage south of B371
33703	Semiannual	Sentinel	Oil Burn Pit #1	AL/BD	Monitor VOC Plume front in buried drainage south of B371
33905	Every other year	Evaluation	North IA	AL/BD	Monitor North IA Plume by drainage between B371 and B559
37405	Semiannual	Sentinel	B371/374	AL/BD	Monitor downgradient of B371/374
37505	Semiannual	Sentinel	B371/374	AL/BD	Monitor downgradient of B371/374
37705	Semiannual	Sentinel	B371/374	AL/BD	Monitor downgradient of B371/374
40005	Every other year	Evaluation	B444	AL/BD	Monitor South IA Plume at VOC source area near B444
40205	Every other year	Evaluation	B444	AL/BD	Monitor South IA Plume downgradient of VOC source area near B444
40305	Semiannual	Sentinel	B444	AL/BD	Monitor South IA Plume downgradient of VOC source area near B444
41691	Annual	Boundary	Walnut Creek at Indiana Street	AL	Monitor ground water in Walnut Creek drainage at Indiana Street
42505	Semiannual	AOC	700 Area at North Walnut Creek	AL/BR	Monitor downgradient of 700 area, IHSS 118.1, and unnamed drainage at confluence with North Walnut Creek

Table B−1 (continued). Proposed Monitoring Locations

Location	Frequency	Class	Plume or Area	Formation	Purpose
45605	Semiannual	Sentinel	Southwest of B991	AL	Monitor adjacent to interrupted perforated line feeding SW056
50299	Every other year	Evaluation	903 Pad/Lip Area	BD	Monitor Ryan's Pit/903 Pad Plume
51605	Semiannual	Sentinel	North Walnut Creek	AL	Monitor downgradient of Solar Ponds Plume at Pond A-1; also supports Decision Document for associated ground water treatment system
52505	Semiannual	Sentinel	North Walnut Tributary Drainage	AL	Monitor drainage between B371/B771
55905	Every other year	Evaluation	B559	AL/BD	Monitor downgradient of B559, 700 Area, North IA Plume
56305	Every other year	Evaluation	B559	AL/BD	Monitor downgradient of B559, 700 Area, and North IA Plume near drainage between B371 and B559
70099	Semiannual	Decision Document	SPPTS	AL	Monitor ground water near western end of SPPTS in accordance with associated Decision Document
70193	Quarterly	RCRA	Present Landfill	BD	Monitor upgradient Present Landfill ground water quality
70299	Semiannual	Sentinel	SPPTS	BD	Monitor ground water near western end of SPPTS
70393	Quarterly	RCRA	Present Landfill/PU&D	AL	Monitor upgradient Present Landfill ground water quality
70693	Quarterly	RCRA	Present Landfill/PU&D	AL	Monitor upgradient Present Landfill/downgradient PU&D Yard ground water quality
70705	Every other year	Evaluation	700 Area	AL/BD	Monitor 700 Area, North IA Plume
73005	Quarterly	RCRA	Present Landfill	BD	Monitor downgradient Present Landfill ground water quality
73105	Quarterly	RCRA	Present Landfill	AL/BD	Monitor downgradient Present Landfill ground water quality
73205	Quarterly	RCRA	Present Landfill	AL/BD	Monitor downgradient Present Landfill ground water quality
79102	Every other year	Evaluation	Solar Ponds	BD	Monitor SEP VOC and U/N plumes source area
79202	Every other year	Evaluation	Solar Ponds	BD	Monitor SEP VOC and U/N plumes source area

Table B−1 (continued). Proposed Monitoring Locations

Location	Frequency	Class	Plume or Area	Formation	Purpose
79302	Every other year	Evaluation	Solar Ponds	BD	Monitor SEP U/N plume source area
79402	Every other year	Evaluation	Solar Ponds	AL/BD	Monitor SEP U/N plume source area
79502	Every other year	Evaluation	Solar Ponds	AL/BD	Monitor SEP U/N plume source area
79605	Every other year	Evaluation	Solar Ponds	BD	Monitor SEP U/N plume source area
80005	Quarterly	RCRA	Original Landfill	AL/BD	Monitor downgradient Original Landfill ground water quality
80105	Quarterly	RCRA	Original Landfill	AL/BD	Monitor downgradient Original Landfill ground water quality
80205	Quarterly	RCRA	Original Landfill	AL/BD	Monitor downgradient Original Landfill ground water quality
88104	Semiannual	Sentinel	B881	AL/BD	Monitor flow from B881, 800 Area toward Woman Creek
89104	Semiannual	AOC	OU1/Woman Creek	AL/BD	Monitor OU1 Plume front downgradient of French drain-SID diversion
891WEL	Quarterly	Decision Document	OU1	AL	Monitor OU1 Plume source area in accordance with OU1 CAD/ROD
90299	Semiannual	Sentinel	903 Pad/Ryan’s Pit	AL/BD	Monitor downgradient Ryan’s Pit/903 Pad Plume
90399	Semiannual	Sentinel	903 Pad/Ryan’s Pit	AL/BD	Monitor downgradient Ryan’s Pit/903 Pad Plume
90402	Every other year	Evaluation	903 Pad	AL/BD	Monitor southeastward flow of 903 Pad Plume
90804	Every other year	Evaluation	Ryan’s Pit/903 Pad	AL/BD	Monitor Ryan's Pit/903 Pad Plume
91105	Every other year	Evaluation	Oil Burn Pit #2	BD	Monitor Oil Burn Pit #2 source area
91203	Semiannual	Sentinel	Oil Burn Pit #2	AL/BD	Monitor downgradient Oil Burn Pit #2
91305	Semiannual	Sentinel	South Walnut Creek	AL	Monitor South Walnut Creek immediately east of B991 and northwest of Oil Burn Pit #2
95099	Semiannual	Sentinel	East Trenches	AL	Monitor downgradient of ETPTS
95199	Semiannual	Sentinel	East Trenches	AL	Monitor downgradient of ETPTS
95299	Semiannual	Sentinel	East Trenches	AL/BD	Monitor downgradient of ETPTS

Table B−1 (continued). Proposed Monitoring Locations

Location	Frequency	Class	Plume or Area	Formation	Purpose
99305	Semiannual	Sentinel	B991/Solar Ponds	AL/BD	Monitor downgradient of B991, SEPs
99405	Semiannual	Sentinel	B991/Solar Ponds	BD	Monitor downgradient of B991, SEPs
B206989	Semiannual	Sentinel	Present Landfill	AL	Monitor downgradient Present Landfill/East Landfill Pond ground water quality
B210489	Every other year	Evaluation	North Walnut Creek	AL	Monitor Solar Pond Plume at North Walnut Creek
P114689	Every other year	Evaluation	IA	AL	Monitor IA Plume near B559
P115589	Every other year	Evaluation	IA	AL	Monitor IA Plume near B551
P208989	Every other year	Evaluation	Solar Ponds	BD	Monitor SEP VOC and U/N plumes source area
P210089	Semiannual	Sentinel	North Walnut Creek	BD	Monitor Solar Pond Plume between SEPs and SPPTS
P210189	Every other year	Evaluation	Solar Ponds	BD	Monitor SEP VOC and U/N plumes source area
P416589	Quarterly	RCRA	Original Landfill	AL	Monitor upgradient of Original Landfill
P416889	Every other year	Evaluation	IA	BD	Monitor downgradient of B444 and South IA Plume
P419689	Every other year	Evaluation	B444	AL/BD	Monitor South IA Plume downgradient of VOC source area near B444
TH046992	Semiannual	Sentinel	South Walnut Creek	AL	Monitor downgradient of ETPTS at South Walnut Creek
MOUND R1-0	Semiannual	Treatment System	MSPTS	--	MSPTS Influent
MOUND R2-E	Semiannual	Treatment System	MSPTS	--	MSPTS Effluent
GS10	Semiannual	Treatment System	MSPTS	--	Monitor surface water quality in South Walnut Creek downstream of MSPTS effluent discharge to this creek
ET INFLUENT	Semiannual	Treatment System	ETPTS	--	ETPTS Influent
ET EFFLUENT	Semiannual	Treatment System	ETPTS	--	ETPTS Effluent
POM2	Semiannual	Treatment System	ETPTS	--	Monitor surface water quality in South Walnut Creek downstream of ETPTS effluent discharge to this creek
SPPMM01	Semiannual	Treatment System	SPPTS	--	SPPTS Effluent

Table B–1 (continued). Proposed Monitoring Locations

Location	Frequency	Class	Plume or Area	Formation	Purpose
SPPMM02	Semiannual	Treatment System	SPPTS	--	SPPTS Influent
SPP DIS GALLERY	Semiannual	Treatment System	SPPTS	--	SPPTS discharge to North Walnut Creek
GS13	Semiannual	Treatment System	SPPTS	--	Monitor surface water quality in North Walnut Creek downstream of SPPTS effluent discharge to this creek
POM3	Semiannual	Surface Water Support	South Walnut Creek	--	Monitor surface water quality in South Walnut Creek downgradient of ETPTS intercept trench
SW018	Semiannual	Surface Water Support	Unnamed tributary to North Walnut Creek	--	Monitor surface water quality in unnamed tributary to North Walnut Creek downgradient of IHSS 118.1

Notes:
AL = Alluvium or other unconsolidated surficial material
AOC = Area of concern
B = Building
BD = Upper hydrostratigraphic unit bedrock
CAD/ROD = Corrective Action Decision/Record of Decision
ETPTS = East Trenches Plume Treatment System
IA = Industrial Area
IHSS = Individual Hazardous Substance Site
MSPTS = Mound Site Plume Treatment System
OU = Operable Unit
PU&D = Property utilization and disposal
RCRA = Resource Conservation and Recovery Act
SEP = Solar Evaporation Ponds, Solar Ponds
SID = South Interceptor Ditch
SPPTS = Solar Ponds Plume Treatment System
U/N = Uranium, nitrate
VOC = Volatile organic compounds

End of current text

Table B−2. Analyte Suite

Well Number	Frequency	Plume or Area	Drivers	VOC Suite	Uranium[a]	Nitrate	Metals Suite	Pu/Am	Gross Alpha and Beta	SVOCs	Pesticides
00191	Every other year	903 Pad	RFCA	X							
00193	Semiannual	Woman Creek drainage at Pond C-2	RFCA	X	X						
00203	Every other year	Southeast flow from 700 Area and SEPs	RFCA	X	X	X					
0487	Quarterly	OU1 Plume	OU1 CAD/ROD	X							
00491	Every other year	Ryan's Pit/903 Pad Plume	RFCA	X							
00797	Semiannual	Flowpath from B881 to Woman Creek	RFCA	X	X						
00897	Every other year	Mound Plume source area	RFCA	X							
00997	Semiannual	South Walnut Creek drainage at Pond B-5	RFCA	X	X	X					
1786	Semiannual	Downgradient SPPTS	SPPTS DD		X	X					
3586	Semiannual	South Walnut Creek downgradient of MSPTS	MSPTS DD	X	X			X	X		
3687	Every other year	East Trenches Plume source area	RFCA	X							
03991	Every other year	East component of East Trenches Plume toward South Walnut Creek	RFCA	X							
4087	Semiannual	Downgradient Present Landfill ground water quality	RFCA	X	X	X					
04091	Semiannual	East component of East Trenches Plume toward South Walnut Creek	RFCA	X							
4787	Semiannual	OU1 Plume	OU1 CAD/ROD	X							
4887	Semiannual	OU1 Plume	OU1 CAD/ROD	X							
05691	Every other year	East Trenches Plume source area	RFCA	X							
07391	Every other year	Ryan's Pit source area	RFCA	X	X						
10304	Semiannual	Woman Creek below Ryan's Pit/903 Pad Plume	RFCA	X	X	X					
10394	Annual	Woman Creek at Indiana Street	RFCA	X	X	X					
10594	Semiannual	North Walnut Creek drainage below Pond A-1	RFCA	X	X	X					
10992	Semiannual	OU1 Plume	OU1 CAD/ROD	X							
11092	Semiannual	OU1 Plume	OU1 CAD/ROD	X							
11104	Semiannual	Woman Creek below South IA Plume and distal Original Landfill	RFCA	X	X						
11502	Semiannual	South IA Plume and B444 flow toward Woman Creek	RFCA	X	X						
15699	Semiannual	Downgradient MSPTS ground water quality	RFCA	X							
18199	Every other year	IHSS 118.1 source area removal	RFCA	X							
20205	Semiannual	B771/774, 700 Area, IHSS 118.1	RFCA	X	X			X			
20505	Semiannual	B771/774, 700 Area, IHSS 118.1	RFCA	X	X			X			
20705	Semiannual	700 Area, IHSS 118.1, and unnamed drainage as it reaches North Walnut Creek	RFCA	X	X	X		X			
20902	Every other year	IHSS 118.1 and 700 Area at drainage between B371 and B771	RFCA	X							
21505	Every other year	700 Area and B559 at drainage between B371 and B776	RFCA	X							
22205	Every other year	Downgradient (north) tip of SEP VOC plume toward North Walnut Creek	RFCA	X	X	X					
22996	Every other year	800 Area ground water flowing east	RFCA	X	X						
23296	Semiannual	Downgradient ETPTS ground water quality	RFCA	X	X						
30002	Semiannual	North Walnut Creek below PU&D Yard Plume	RFCA	X							
30900	Every other year	PU&D Yard Plume source area	RFCA	X							
33502	Every other year	Oil Burn Pit #1 source area	RFCA	X							
33604	Every other year	Oil Burn Pit #1 source area	RFCA	X							
33703	Semiannual	Downgradient of Oil Burn Pit #1	RFCA	X							
33905	Every other year	North IA Plume by drainage between B371 and B559	RFCA	X							
37405	Semiannual	B371/374	RFCA	X	X	X		X			
37505	Semiannual	B371/374	RFCA	X	X	X					
37705	Semiannual	B371/374	RFCA	X	X	X		X			
40005	Every other year	South IA Plume at VOC source area near B444	RFCA	X	X						
40205	Every other year	South IA Plume downgradient of VOC source area near B444	RFCA	X	X						
40305	Semiannual	South IA Plume downgradient of VOC source area near B444	RFCA	X	X						

Table B−2 (continued). Analyte Suite

Well Number	Frequency	Plume or Area	Drivers	VOC Suite	Uranium[a]	Nitrate	Metals Suite	Pu/Am	Gross Alpha and Beta	SVOCs	Pesticides
41691	Annual	Walnut Creek at Indiana Street	RFCA	X	X	X					
42505	Semiannual	FC-2/FC-3 confluence	RFCA	X							
45605	Semiannual	Area where drain that used to feed SW056 is interrupted	RFCA	X							
50299	Every other year	Ryan's Pit/903 Pad Plume	RFCA	X							
51605	Semiannual	Downgradient SPPTS at Pond A-1	RFCA, SPPTS DD		X	X					
52505	Semiannual	Drainage between B371/B771	RFCA	X							
55905	Every other year	B559, 700 Area, North IA Plume	RFCA	X	X	X					
56305	Every other year	B559, 700 Area, and North IA Plume near drainage between B371 and B559	RFCA	X	X	X					
70099	Semiannual	SPPTS bypass	SPPTS DD		X	X					
70193	Quarterly	Upgradient Present Landfill ground water quality	RCRA	X			X				
70299	Semiannual	SPPTS bypass	RFCA, SPPTS DD		X	X					
70393	Quarterly	Upgradient Present Landfill ground water quality	RCRA	X			X				
70693	Quarterly	Upgradient Present Landfill/downgradient PU&D Yard ground water quality	RCRA	X			X				
70705	Every other year	700 Area, North IA Plume	RFCA	X	X						
73005	Quarterly	Present Landfill	RCRA	X			X				
73105	Quarterly	Present Landfill	RCRA	X			X				
73205	Quarterly	Present Landfill	RCRA	X			X				
79102	Every other year	SEP VOC and U/N plumes source area	RFCA	X	X	X					
79202	Every other year	SEP VOC and U/N plumes source area	RFCA	X	X	X					
79302	Every other year	SEP U/N plume source area	RFCA		X	X					
79402	Every other year	SEP U/N plume source area	RFCA		X	X					
79502	Every other year	SEP U/N plume source area	RFCA		X	X					
79605	Every other year	SEP U/N plume source area	RFCA		X	X					
80005	Quarterly	Downgradient Original Landfill	RCRA, RFCA	X			X			X	
80105	Quarterly	Downgradient Original Landfill	RCRA, RFCA	X			X			X	
80205	Quarterly	Downgradient Original Landfill	RCRA, RFCA	X			X			X	
88104	Semiannual	B881, 800 Area toward Woman Creek	RFCA	X	X						
88205	Every other year	B881	RFCA	X	X						
89104	Semiannual	OU1 Plume downgradient of French drain-SID diversion	RFCA	X							
891WEL	Quarterly	OU1 Plume source area	OU1 CAD/ROD	X							
90299	Semiannual	Downgradient Ryan's Pit/903 Pad Plume	RFCA	X							
90399	Semiannual	Downgradient Ryan's Pit/903 Pad Plume	RFCA	X							
90402	Every other year	903 Pad	RFCA	X							
90804	Every other year	Ryan's Pit/903 Pad Plume	RFCA	X							
91105	Every other year	Oil Burn Pit #2 source area	RFCA	X							
91203	Semiannual	Downgradient Oil Burn Pit #2	RFCA	X							
91305	Semiannual	South Walnut Creek immediately east of B991 and northeast of Oil Burn Pit #2	RFCA	X	X	X					
95099	Semiannual	Downgradient ETPTS	RFCA, ETPTS DD	X							
95199	Semiannual	Downgradient ETPTS	RFCA, ETPTS DD	X							
95299	Semiannual	Downgradient ETPTS	RFCA, ETPTS DD	X							
99305	Semiannual	B991, SEPs	RFCA	X	X	X					
99405	Semiannual	B991, SEPs	RFCA	X	X	X					
B206989	Semiannual	Downgradient Present Landfill ground water quality	RFCA	X	X	X					

Table B−2 (continued). Analyte Suite

Well Number	Frequency	Plume or Area	Drivers	VOC Suite	Uranium[a]	Nitrate	Metals Suite	Pu/Am	Gross Alpha and Beta	SVOCs	Pesticides
B210489	Every other year	Downgradient SPPTS at North Walnut Creek	RFCA		X	X					
P114689	Every other year	IA Plume near B559	RFCA	X							
P115589	Every other year	IA Plume near B551	RFCA	X							
P208989	Every other year	SEP VOC and U/N plumes source area	RFCA	X	X	X					
P210089	Semiannual	North of SEPs next to North Walnut Creek, above SPPTS	RFCA	X	X	X					
P210189	Every other year	SEP VOC and U/N plumes source area	RFCA	X	X	X					
P416589	Quarterly	Upgradient of Original Landfill	RCRA, RFCA	X			X			X	
P416889	Every other year	Downgradient of B444 and South IA Plume	RFCA	X	X						
P419689	Every other year	South IA Plume downgradient of VOC source area near B444	RFCA	X	X						
TH046992	Semiannual	Downgradient of ETPTS	RFCA	X							
MOUND R1-0	Semiannual	MSPTS Influent	RFCA	X	X			X	X		
MOUND R2-E	Semiannual	MSPTS Effluent	RFCA, MSPTS DD	X	X			X	X		
GS10	Semiannual	South Walnut Creek downstream of MSPTS effluent discharge to this creek	RFCA	X							
ET INFLUENT	Semiannual	ETPTS Influent	RFCA, ETPTS DD	X							
ET EFFLUENT	Semiannual	ETPTS Effluent	RFCA, ETPTS DD	X							
POM2	Semiannual	South Walnut Creek Pond B-4, downstream of ETPTS effluent discharge to this creek	RFCA	X							
SPPMM01	Semiannual	SPPTS Effluent	RFCA, SPPTS DD		X	X					
SPPMM02	Semiannual	SPPTS Influent	RFCA, SPPTS DD		X	X					
SPP DIS GALLERY	Semiannual	SPPTS discharge to North Walnut Creek	RFCA		X	X					
GS13	Semiannual	North Walnut Creek downstream of SPPTS effluent discharge to this creek	RFCA, SPPTS DD		X	X					
POM3	Semiannual	South Walnut Creek Pond B-2	RFCA	X							
SW018	Semiannual	Downgradient of IHSS 118.1	RFCA	X							

Notes:
[a]Uranium analysis will be for total uranium at all locations except at GS13, which will be isotopic uranium.

B = Building
DD = Decision Document
IA = Industrial Area
MSPTS = Mound Site Plume Treatment System
Pu/Am = Plutonium/americium
RCRA = Resource Conservation and Recovery Act
SEP = Solar Evaporation Ponds, Solar Ponds
SPPTS = Solar Ponds Plume Treatment System
VOC = Volatile organic compounds
CAD/ROD = Corrective Action Decision/Record of Decision
ETPTS = East Trenches Plume Treatment System
IHSS = Individual Hazardous Substance Site
OU = Operable Unit
PU&D = Property utilization and disposal
RFCA = *Rocky Flats Cleanup Agreement*
SID = South Interceptor Ditch
U/N = Uranium, nitrate

Table B−3. Site-Wide Water-Level Monitoring

Well	Water Quality	Water Level Only
00191	2	
00193	2	
00203	2	
0487	4	
00491	2	
00797	2	
00897	2	
00997	2	
1786	2	
3586	2	
3687	2	
03991	2	
4087	2	
04091	2	
4787	2	
4887	2	
05691	2	
07391	2	
10304	2	
10394	2	
10594	2	
10992	2	
11092	2	
11104	2	
11502	2	
15199		2
15299		2
15399		2
15499		2
15599		2
15699	2	
15799		2
16199		2
16299		2
16399		2
16499		2
16599		2
18199	2	
20205	2	
20505	2	
20705	2	
20902	2	
21002		2
21305		2
21505	2	
21605		2
22205	2	

Table B−3 (continued). Site-Wide Water-Level Monitoring

Well	Water Quality	Water Level Only
22996	2	
23296	2	
30002	2	
30900	2	
33502	2	
33604	2	
33703	2	
33905	2	
37105		2
37405	2	
37505	2	
37591		2
37691		2
37705	2	
39605		2
40005	2	
40205	2	
40305	2	
41691	2	
42505	2	
45605	2	
50299	2	
51605	2	
52505	2	
55905	2	
56305	2	
70099	2	
70193	4	
70299	2	
70393	4	
70693	4	
70705	2	
70799		2
70899		2
70999		2
71099		2
73005	4	
73105	4	
73205	4	
79102	2	
79202	2	
79302	2	
79402	2	
79502	2	
79605	2	
80005	4	
80105	4	
80205	4	
88104	2	

Table B−3 (continued). Site-Wide Water-Level Monitoring

Well	Water Quality	Water Level Only
88205	2	
89104	2	
891WEL	4	
90299	2	
90399	2	
90402	2	
90804	2	
91105	2	
91203	2	
91305	2	
95099	2	
95199	2	
95299	2	
95699		2
95799		2
95899		2
99305	2	
99405	2	
B206989	2	
B210489	2	
P114389		2
P114689	2	
P115589	2	
P208989	2	
P210089	2	
P210189	2	
P416589	4	
P416889	2	
P419689	2	
TH046992	2	

Notes:
Numbers in columns denote *minimum* measurement frequency per year.
Wells listed under “Water Quality” are also scheduled for routine analytical sampling; those under “Water Level” are scheduled for water-level monitoring only.

Table B−4. Well Crosswalk

Former Well Identification	Replacement Well Identification	General Location
00200	70705	East side of B707
00297	00203	South side of SEPs
1386	51605	North Walnut Creek west of Pond A-1
1986	52505	West of B771/774 in unnamed drainage
2187	91305	South Walnut Creek southeast of B991
5187	88205	South of B881
20298	20205	North of B771/774
20598	20505	North of B771/774
20798	20705	North of B771/774
20998	20902	West of B771 in unnamed drainage
21098	21002	West of B771 in unnamed drainage
21398	21305	West of B776 in unnamed drainage
21598	21505	West of B776 in unnamed drainage
21698	21605	West of B559, B776 in unnamed drainage
22298	22205	North of SEPs
33603	33604	South of B371/374 near Oil Burn Pit #1 source area
33904	33905	Southeast of B371/374
37101	37105	West of B371/374
37401, 37402	37405	North of B371/374
37501	37505	North of B371/374
37701	37705	East of B371/374
39691	39605	West of B881
40099	40005	West of B444
40299	40205	South of B444
40399	40305	East of B444
55901	55905	North of B559
56301	56305	West of B559
88101	88104	South of B881
891COLWEL	891WEL (see notes, below)	OU1 Plume source area
90803	90804	903 Pad/Ryan's Pit Plume
91103, 91104	91105	Oil Burn Pit #2 source area
99301	99305	East of B991
99401	99405	East of B991
P207989	79605	East of SEPs

Notes:
This table is current through August 2005. Any well replacements planned subsequent to that date are not listed above.
Well 891COLWEL was a large-diameter, industrial-pump-equipped collection well. The pump was removed and a 2-inch diameter well was installed within the 1.09-foot diameter casing of 891COLWEL. This 2-inch well was assigned the name 891WEL. Differentiation was necessitated by the resulting changes in sampling methods.
B = Building
OU = Operable Unit
SEPs = Solar Evaporation Ponds

Table B−5. Wildlife Refuge Worker Surface Water Preliminary Remediation Goals

Analyte	CAS Number	WRW Noncarcinogenic Surface Water PRG HQ = 0.1	WRW Carcinogenic Surface Water PRG Risk = 1E-06	WRW Surface Water PRG Risk = 1E-06 or HQ = 0.1	Units
Acenaphthene	83-32-9	121667		121667	µg/L
Acenaphthylene	208-96-8				µg/L
Acetone	67-64-1	1825000		1825000	µg/L
Acrolein	107-02-8	1014		1014	µg/L
Acrylonitrile	107-13-1	2028	141	141	µg/L
Alachlor	15972-60-8	20278	949	949	µg/L
Aldicarb	116-06-3	2028		2028	µg/L
Aldicarb sulfone	1646-88-4	2028		2028	µg/L
Aldicarb sulfoxide	1646-87-3				µg/L
Aldrin	309-00-2	60.8	4.47	4.47	µg/L
Aluminum	7429-90-5	2028		2028	mg/L
Ammonium (as ammonia)	7664-41-7				mg/L
Anthracene	120-12-7	608333		608333	µg/L
Antimony	7440-36-0	0.81		0.81	mg/L
Aroclor 1016	12674-11-2	142	38	38	µg/L
Aroclor 1221	11104-28-2		38	38	µg/L
Aroclor 1232	11141-16-5		38	38	µg/L
Aroclor 1242	53469-21-9		38	38	µg/L
Aroclor 1248	12672-29-6		38	38	µg/L
Aroclor 1254	11097-69-1	40.6	38	38	µg/L
Aroclor 1260	11096-82-5		38	38	µg/L
Arsenic	7440-38-2	0.61	0.05	0.05	mg/L
Atrazine	1912-24-9	70972	345	345	µg/L
Barium	7440-39-3	142		142	mg/L
Benzene	71-43-2	8111	1380	1380	µg/L
Benzidine	92-87-5	6083	0.33	0.33	µg/L
Benzo(a)anthracene	56-55-3		104	104	µg/L
Benzo(a)pyrene	50-32-8		10.4	10.4	µg/L
Benzo(b) fluoranthene	205-99-2		104	104	µg/L
Benzo(g,h,i) perylene	191-24-2				µg/L
Benzo(k) fluoranthene	207-08-9		1040	1040	µg/L
Benzoic Acid (at pH 7)	65-85-0	8111111		8111111	µg/L
Benzyl Alcohol	100-51-6	608333		608333	µg/L
Beryllium	7440-41-7	4.06		4.06	mg/L
Bis(2-chloroethyl)ether	111-44-4		69.0	69.0	µg/L
Bis(2-chloroisopropyl) ether	108-60-1	81111	1084	1084	µg/L
Bis(2-ethylhexyl) phthalate	117-81-7	40556	5422	5422	µg/L
Boron	7440-42-8	183		183	mg/L
Bromodichloro-methane	75-27-4	40556	1224	1224	µg/L
Bromoform	75-25-2	40556	9608	9608	µg/L
Bromomethane (methyl bromide)	74-83-9	2839		2839	µg/L
2-Butanone (methyl ethyl ketone)	78-93-3	1216667		1216667	µg/L

Table B−5 (continued). Wildlife Refuge Worker Surface Water Preliminary Remediation Goals

Analyte	CAS Number	WRW Noncarcinogenic Surface Water PRG HQ = 0.1	WRW Carcinogenic Surface Water PRG Risk = 1E-06	WRW Surface Water PRG Risk = 1E-06 or HQ = 0.1	Units
Butylbenzyl-phthalate	85-68-7	405556		405556	µg/L
Cadmium (water)	7440-43-9	1.01		1.01	mg/L
Carbazole	86-74-8		3795	3795	µg/L
Carbofuran	1563-66-2	10139		10139	µg/L
Carbon disulfide	75-15-0	202778		202778	µg/L
Carbon tetrachloride	56-23-5	1419	584	584	µg/L
Chlordane-alpha	5103-71-9	1014	217	217	µg/L
Chlordane-beta	5103-74-2	1014	217	217	µg/L
Chlordane-gamma	12789-03-6	1014	217	217	µg/L
4-Chloroaniline	106-47-8	8111		8111	µg/L
Chlorobenzene	108-90-7	40556		40556	µg/L
Chloroethane (ethyl chloride)	75-00-3	811111	26175	26175	µg/L
Chloroform	67-66-3	20278		20278	µg/L
Chloromethane (methyl chloride)	74-87-3				µg/L
4-Chloro-3-methylphenol	59-50-7				µg/L
2-Chloronaphthalene	91-58-7	162222		162222	µg/L
2-Chlorophenol	95-57-8	10139		10139	µg/L
Chlorpyrifos	2921-88-2	6083		6083	µg/L
Chromium III	16065-83-1	3042		3042	mg/L
Chromium VI	18540-29-9	6.08		6.08	mg/L
Chrysene	218-01-9		10398	10398	µg/L
Cobalt	7440-48-4	40.6		40.6	mg/L
Copper	7440-50-8	81.1		81.1	mg/L
Cyanide	57-12-5	40.6		40.6	mg/L
Cyclohexane	110-82-7				µg/L
4,4-DDD	72-54-8		316	316	µg/L
4,4-DDE	72-55-9		223	223	µg/L
4,4-DDT	50-29-3		223	223	µg/L
Dalapon	75-99-0	60833		60833	µg/L
Demeton	8065-48-3	81.1		81.1	µg/L
Dibenzo(a,h) anthracene	53-70-3		10.4	10.4	µg/L
Dibenzofuran	132-64-9	4056		4056	µg/L
Dibromochloro-methane	124-48-1	40556	904	904	µg/L
1,2-Dibromo-3-chloropropane	96-12-8		54.2	54.2	µg/L
Di-n-butylphthalate	84-74-2	202778		202778	µg/L
Dicamba	1918-00-9	60833		60833	µg/L
1,2-Dichlorobenzene (o-)	95-50-1	182500		182500	µg/L
1,3-Dichlorobenzene	541-73-1	60833		60833	µg/L
1,4-Dichlorobenzene (p-)	106-46-7	60833	3163	3163	µg/L
3,3-Dichlorobenzidine	91-94-1		169	169	µg/L
Dichlorodifluoro-methane	75-71-8	405556		405556	µg/L
1,1-Dichloroethane	75-34-3	202778		202778	µg/L
1,2-Dichloroethane	107-06-2	40556	834	834	µg/L
1,1-Dichloroethene[a]	75-35-4	101389		101389	µg/L

Table B−5 (continued). Wildlife Refuge Worker Surface Water Preliminary Remediation Goals

Analyte	CAS Number	WRW Noncarcinogenic Surface Water PRG HQ = 0.1	WRW Carcinogenic Surface Water PRG Risk = 1E-06	WRW Surface Water PRG Risk = 1E-06 or HQ = 0.1	Units
1,2-Dichloroethene (total)	540-59-0	18250		18250	µg/L
2,4-Dichlorophenol	120-83-2	6083		6083	µg/L
Dichlorophenoxy-acetic acid (2,4-D)	94-75-7	20278		20278	µg/L
4-(2,4-Dichlorophenoxy) butyric acid (2,4-DB)	94-82-6	16222		16222	µg/L
1,2-Dichloropropane	78-87-5		1116	1116	µg/L
1,3-Dichloropropene	542-75-6	60833	759	759	µg/L
Cis-1,3-Dichloropropene	10061-01-5	60833	759	759	µg/L
Trans-1,3-Dichloropropene	10061-02-6	60833	759	759	µg/L
Dieldrin	60-57-1	101	4.7	4.7	µg/L
Diethyl ether	60-29-7	405556		405556	µg/L
Di(2-ethylhexyl)adipate	103-23-1	1216667	63255	63255	µg/L
Diethylphthalate	84-66-2	1622222		1622222	µg/L
Dimethoate	60-51-5	406		406	µg/L
2,4-Dimethylphenol	105-67-9	40556		40556	ug/L
Dimethylphthalate	131-11-3	20277778		20277778	µg/L
4,6-Dinitro-2-methylphenol (4,6-dinitro-o-cresol)	534-52-1	203		203	µg/L
2,4-Dinitrophenol	51-28-5	4056		4056	µg/L
2,4-Dinitrotoluene	121-14-2	4056		4056	µg/L
2,6-Dinitrotoluene	606-20-2	2028		2028	µg/L
Di-n-octylphthalate	117-84-0	81111		81111	µg/L
Dinoseb	88-85-7	2028		2028	µg/L
1,4-Dioxane	123-91-1		6901	6901	µg/L
Dioxin (TCDD)	1746-01-6		0.0005	0.0005	µg/L
1,2-Diphenylhydrazine	122-66-7		94.9	94.9	µg/L
Diquat	85-00-7	4461		4461	µg/L
Endosulfan I	959-98-8	12167		12167	µg/L
Endosulfan II	33213-65-9	12167		12167	µg/L
Endosulfan sulfate	1031-07-8	12167		12167	µg/L
Endosulfan (technical)	115-29-7	12167		12167	µg/L
Endrin (technical)	72-20-8	608		608	µg/L
Endrin aldehyde	7421-93-4	608		608	µg/L
Endrin ketone	53494-70-5	608		608	µg/L
Ethyl acetate	141-78-6	1825000		1825000	µg/L
Ethylbenzene	100-41-4	202778		202778	µg/L
Ethylene dibromide (1,2-Dibromoethane)	106-93-4		0.89	0.89	µg/L
Fluoranthene	206-44-0	81111		81111	µg/L
Fluorene	86-73-7	81111		81111	µg/L
Fluoride (as fluorine)	7782-41-4	122		122	mg/L
Glyphosate	1071-83-6	202778		202778	µg/L
Guthion	86-50-0				µg/L
Heptachlor	76-44-8	1014	16.9	16.9	µg/L
Heptachlor epoxide	1024-57-3	26.4	8.34	8.34	µg/L

Table B−5 (continued). Wildlife Refuge Worker Surface Water Preliminary Remediation Goals

Analyte	CAS Number	WRW Noncarcinogenic Surface Water PRG HQ = 0.1	WRW Carcinogenic Surface Water PRG Risk = 1E-06	WRW Surface Water PRG Risk = 1E-06 or HQ = 0.1	Units
Hexachlorobenzene	118-74-1	1622	47.4	47.4	µg/L
Hexachlorobutadiene	87-68-3	406	973	406	µg/L
Hexachlorocyclo-hexane, alpha (alpha-BHC)	319-84-6		12.0	12.0	µg/L
Hexachlorocyclo-hexane, beta (beta-BHC)	319-85-7		42.2	42.2	µg/L
Hexachlorocyclo-hexane, delta (delta-BHC)	319-86-8				µg/L
Hexachlorocyclo-hexane, gamma (gamma-BHC)	58-89-9	608	58.4	58.4	µg/L
Hexachlorocyclo-hexane, Technical (Lindane)	608-73-1		42.2	42.2	µg/L
Hexachlorocyclo-pentadiene	77-47-4	12167		12167	µg/L
Hexachlorodibenzo-p-dioxin	34465-46-8		0.012	0.012	µg/L
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	57653-85-7		0.012	0.012	µg/L
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	19408-74-3		0.012	0.012	µg/L
Hexachloroethane	67-72-1	2028	5422	2028	µg/L
Indeno(1,2,3-cd)pyrene	193-39-5		104	104	µg/L
Iron	7439-89-6	608		608	µg/L
Isobutyl alchohol	78-83-1	608333		608333	µg/L
Isophorone	78-59-1	405556	79901	79901	µg/L
Isopropylbenzene (cumene)	98-82-8	202778		202778	µg/L
Lead	7439-92-1				mg/L
Lithium	7439-93-2	40.6		40.6	mg/L
Manganese (food)	7439-96-5	284		284	mg/L
Mercury	7439-97-6	0.61		0.61	mg/L
Methoxychlor	72-43-5	10139		10139	µg/L
2-Methyl-4-chlorophenoxyacetic acid (MCPA)	94-74-6	1014		1014	µg/L
2-(2-Methyl-4-chlorophenoxy) propionic acid (MCPP)	93-65-2	2028		2028	µg/L
Methylene chloride (dichloromethane)	75-09-2	121667	10121	10121	µg/L
Methyl methacrylate	80-62-6	2838889		2838889	µg/L
2-Methylnaphthalene	91-57-6	8111		8111	µg/L
4-Methyl-2-pentanone (methyl isobutyl ketone)	108-10-1				µg/L
2-Methylphenol (o-cresol)	95-48-7	101389		101389	µg/L
4-Methylphenol (p-cresol)	106-44-5	10139		10139	µg/L
Methyl tert-butyl ether	1634-04-4		18977	18977	µg/L
Mirex	2385-85-5	406		406	µg/L
Molybdenum	7439-98-7	10.1		10.1	mg/L

Table B−5 (continued). Wildlife Refuge Worker Surface Water Preliminary Remediation Goals

Analyte	CAS Number	WRW Noncarcinogenic Surface Water PRG HQ = 0.1	WRW Carcinogenic Surface Water PRG Risk = 1E-06	WRW Surface Water PRG Risk = 1E-06 or HQ = 0.1	Units
Naphthalene	91-20-3	40556		40556	µg/L
Nickel (soluble)	7440-02-0	40.6		40.6	mg/L
Nitrate	14797-55-8	3244		3244	mg/L
Nitrite	14797-65-0	203		203	mg/L
2-Nitroaniline	88-74-4	6083		6083	µg/L
4-Nitroanaline	100-01-6	6083	3795	3795	µg/L
Nitrobenzene	98-95-3	1014		1014	µg/L
4-Nitrophenol	100-02-7	16222		16222	µg/L
N-Nitroso-di-n-butylamine	924-16-3		14.1	14.1	µg/L
N-Nitrosodiethylamine	55-18-5		0.51	0.51	µg/L
N-Nitrosodimethyl-amine	62-75-9		1	1	µg/L
N-Nitrosodiphenyl-amine	86-30-6	40556	15491	15491	µg/L
N-Nitrosodi-N-propylamine	621-64-7		10.8	10.8	µg/L
N-Nitrosopyrrolidine	930-55-2		36.1	36.1	µg/L
p-Nitrotoluene	99-99-0		4465	4465	µg/L
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	101389		101389	µg/L
Oxamyl (vydate)	23135-22-0	50694		50694	µg/L
Parathion	56-38-2	12167		12167	µg/L
Pentachlorobenzene	608-93-5	1622		1622	µg/L
Pentachlorophenol	87-86-5	60833	633	633	µg/L
Phenanthrene	85-01-8				µg/L
Phenol	108-95-2	608333		608333	µg/L
Picloram	1918-02-1	141944		141944	µg/L
Pyrene	129-00-0	60833		60833	µg/L
Selenium	7782-49-2	10.1		10.1	mg/L
Silver	7440-22-4	10.1		10.1	mg/L
Simazine	122-34-9	10139	633	633	µg/L
Strontium	7440-24-6	1217		1217	mg/L
Styrene	100-42-5	405556		405556	µg/L
Sulfide	18496-25-8				mg/L
1,2,4,5-Tetrachlorobenzene	95-94-3	608		608	µg/L
1,1,1,2-Tetrachloroethane	630-20-6	60833	2919	2919	µg/L
1,1,2,2-Tetrachloroethane	79-34-5	121667	380	380	µg/L
Tetrachloroethene	127-18-4	20278	141	141	µg/L
2,3,4,6-Tetrachlorophenol	58-90-2	60833		60833	µg/L
Thallium	7440-28-0	0.14		0.14	mg/L
Tin	7440-31-5	1217		1217	mg/L
Titanium	7440-32-6	8111		8111	mg/L
Toluene	108-88-3	405556		405556	µg/L
Toxaphene	8001-35-2		69.0	69.0	µg/L
1,2,4-Trichlorobenzene	120-82-1	20278		20278	µg/L
1,1,1-Trichloroethane	71-55-6	567778		567778	µg/L
1,1,2-Trichloroethane	79-00-5	8111	1332	1332	µg/L

Table B−5 (continued). Wildlife Refuge Worker Surface Water Preliminary Remediation Goals

Analyte	CAS Number	WRW Noncarcinogenic Surface Water PRG HQ = 0.1	WRW Carcinogenic Surface Water PRG Risk = 1E-06	WRW Surface Water PRG Risk = 1E-06 or HQ = 0.1	Units
Trichloroethene[a]	79-01-6	608	190	190	µg/L
Trichlorofluoro-methane	75-69-4	608333		608333	µg/L
2,4,5-Trichlorophenol	95-95-4	202778		202778	µg/L
2,4,6-Trichlorophenol	88-06-2		6901	6901	µg/L
Trichlorophenoxy-proprionic acid	93-72-1	16222		16222	µg/L
1,2,3-Trichloropropane	96-18-4	12167	38.0	38.0	µg/L
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	60833333		60833333	µg/L
2,4,6-Trinitrotoluene	118-96-7	1014	2530	1014	µg/L
Uranium (soluble salts)	7440-61-1	6.08		6.08	mg/L
Vanadium	7440-62-2	2.03		2.03	mg/L
Vinyl acetate	108-05-4	2027778		2027778	µg/L
Vinyl chloride	75-01-4	6083	50.6	50.6	µg/L
Xylene (total)	1330-20-7	405556		405556	µg/L
p-Xylene	106-42-3	405556		405556	µg/L
m-p-Xylene	136777-61-2	405556		405556	µg/L
m-Xylene	108-38-3	405556		405556	µg/L
o-Xylene	95-47-6	405556		405556	µg/L
Zinc	7440-66-6	608		608	mg/L
Am-241	14596-10-2		408	408	pCi/L
Cs-137+D	10045-97-3		1396	1396	pCi/L
Np-237	013994-20-2		687	687	pCi/L
Pu-236	015411-92-4		568	568	pCi/L
Pu-238	013981-16-3		324	324	pCi/L
Pu-239	15117-48-3		314	314	pCi/L
Pu-240	14119-33-6		314	314	pCi/L
Ra-226	13982-63-3		110	110	pCi/L
Ra-228+D	15262-20-1		41	41	pCi/L
Sr-89	14158-27-1		3316	3316	pCi/L
Sr-90+D	10098-97-2		574	574	pCi/L
Tritium	10028-17-8		837105	837105	pCi/L
U-233	13968-55-3		591	591	pCi/L
U-234	13966-29-5		600	600	pCi/L
U-235	15117-96-1		610	610	pCi/L
U-238	7440-61-1		663	663	pCi/L

From Table A-6 in Kaiser-Hill 2004e.
[a]Values recommended by Colorado Department of Public Health and Environment.
Notes:
CAS = Chemical Abstract Service
HQ = Hazard Quotient
mg/L = Milligrams per liter
pCi/L = Picocuries per liter
µg/L = Micrograms per liter
WRW SWPRG = Wildlife Refuge Worker Surface Water Preliminary Remediation Goals

Table B−6 Total Uranium Lookup Table

The following table will be used for comparisons against the highest pre-calendar year 2005 U concentration in a well. (See Section 3.3.3.5 of the FY 2005 IMP Background Document, Rev. 1, for a discussion on the use of this table.) These data summarize the maximum U concentrations for all wells in the revised FY 2005 IMP ground water monitoring network that are represented by U data dating from between January 1, 2000 and December 31, 2004, as well as any HR ICP/MS or TIMS U data reported by Los Alamos National Laboratory prior to December 31, 2004. This time frame is discussed further in Section 3.3.3.1 of the above-referenced FY 2005 IMP.

Well/Replacement Well[a]	IMP Classification	Maximum Uranium Concentration[b]	Units
11104	AOC	61.1	µg/L
10594	AOC	155	µg/L
10304	AOC	11.71509	µg/L
00997	AOC	21.15954	µg/L
00193	AOC	114.1448	µg/L
41691	Boundary	8.171961	µg/L
10394	Boundary	10.17263	µg/L
P210089	Sentinel	12.7862	µg/L
B206989	Sentinel	144.7605	µg/L
99401/99405	Sentinel	831.4971	µg/L
99301/99305	Sentinel	544	µg/L
91203	Sentinel	3.74	µg/L
90399	Sentinel	21.09388	µg/L
90299	Sentinel	118	µg/L
88101/88105	Sentinel	629.0951	µg/L
70299	Sentinel	22.20147	µg/L
4087	Sentinel	63.62	µg/L
40399/40305	Sentinel	0.583712	µg/L
37701/37705	Sentinel	18.70795	µg/L
37501/37505	Sentinel	2.615028	µg/L
37401/37402/37405	Sentinel	73.62062	µg/L
23296	Sentinel	53.77442	µg/L
2187/91305	Sentinel	36	µg/L
20798/20705	Sentinel	1.009821	µg/L
20598/20505	Sentinel	9.59	µg/L
20298/20205	Sentinel	40.2	µg/L
1986/52505	Sentinel	10.61042	µg/L
15699	Sentinel	44.57221	µg/L
1386/51605	Sentinel	35.58451	µg/L
11502	Sentinel	3.12	µg/L
04091	Sentinel	4.656559	µg/L
00797	Sentinel	27.39066	µg/L

[a]The maximum value for a given location is used regardless of whether it is from a replacement well or its predecessor.
[b]The value shown represents the maximum of three possible values: data reported as total U in µg/L; data reported as isotopic U in ppb and then summed; or data reported as isotopic U in pCi/L, converted to µg/L using isotope-specific conversion factors, and then summed.

Notes: AOC = Area of Concern IMP = Integrated Monitoring Plan
pCi/L = Picocuries per liter ppb = Parts per billion
U = Uranium µg/L = Micrograms per liter

End of current text